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Can socialist property rights be compatible with technological catching up?

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* Tel. 022–907.5733; Fax 907.0274; E.mail: nicole.winch@unctad.org

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Contents

Abbreviations

AMC	asset management company
COE	collectively owned enterprise
CRS	Enterprise Contract Responsibility System
EIU	Economist Intelligence Unit
GDP	gross domestic product
FDI	foreign direct investment
HRS	household responsibility system
K/L	capital over labour
LME	large and medium-scale enterprises
M&A	mergers and acquisitions
MOST	Ministry of Science and Technology
NIE	newly industrializing economy
NSI	national system of innovation
OECD	Organisation for Economic Co-operation and Development
R&D	research and development
S&T	science and technology
SETC	State Economic and Trade Commission
SME	small and medium enterprise
SOE	state-owned enterprise
SSB	State Statistical Bureau
SSTC	State Science and Technology Commission
TNC	transnational corporation
TFP	total factor productivity
TVE	township and village enterprise
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
WTO	World Trade Organization

SCIENCE AND TECHNOLOGY POLICIES, INDUSTRIAL REFORM AND TECHNICAL PROGRESS IN CHINA

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Abstract

This paper analyses the quest for technological progress in China, a large, semi-industrialized, socialist developing country. In the introduction, it is argued that international income convergence is not an automatic product of market forces. Therefore, the path of technological progress in a less advanced country is dependent on its absorptive capacity, which can be enhanced by the development of an effective national innovation system. The specific meaning attached to key terms such as technological progress, market-compatibility and "socialism" are also explained. Section II briefly illustrates the relative position of China in the international division of labour, as well as some basic economic and social indicators. Section III contends that the huge amount of FDI flowing to China is not per se a major source of technical progress, but important gains can be obtained through strategic bargaining with large transnational corporations from industrialized countries. Section IV sketches the main lines of evolution of Chinese technological culture since the inception of the reforms and provides basic data on China's R&D system. Section V analyses the new focus of innovation and research policies and describes the major science and technology programmes. Section VI shifts the analysis to the level of industrial enterprises, arguing that a kind of symbiosis exists among the two groups of public firms. Collective enterprises realize their comparative advantage specializing in simpler industrial activities and benefit from technological spillovers from state-owned enterprises, while the latter are undergoing a process of upgrading and rationalization in order to gain a strong position at the upper end of the technological spectrum. This section also presents and illustrates aggregate data on production and employment trends in China's industry and proposes a tentative estimate of the technical change component of labour productivity growth in state-owned enterprises, showing that it has been substantial and increased in the late 1990s. Section VII concludes that China's experience so far shows that a radical improvement in a socialist economy's ability to achieve technical progress is not inconsistent with the reaffirmation, in a new and diversified form, of a fundamentally public framework of property relations.

I. INTRODUCTION

This paper focuses on some aspects of the catching-up effort being carried out in a socialist developing country such as China. In this introduction, besides mentioning some of the topics that will be discussed, I shall specify the function and meaning to be attached to a few basic concepts in order to clarify the theoretical background referred to in parts of the text.

Some policy-related features of China's overall development strategy will be examined from the point of view of the pursuit of a single crucial goal, which is technical progress. The concept of technical progress used in this paper is broad and goes beyond the scientific and technical innovations stemming directly and indirectly from R&D activities aimed at the generation of new knowledge. In fact, technical progress also encompasses the web of imitative and adaptive changes – in the realms of production organization, product design, materials and energy consumption, procurement, sales and distribution, management, finance, administration, and other economically relevant activities – which result in higher

productivity and jointly foster the progressive climbing of the technological ladder and a more favourable position in the international division of labour. As the most widely used, if imperfect, quantitative indicator of technical progress is the evolution of total factor productivity (TFP) the paper will also review the debate on the estimates of TFP growth in different sectors of the Chinese economy, and especially in the reforming sector of industrial state-owned enterprises (SOEs). Other related topics, such as the technical progress-enhancing potential of foreign direct investment (FDI) and of cooperation with large transnational corporations (TNCs) from developed countries, will also be briefly examined in the first part of section II. However, the core of the paper is constituted by an analysis of the evolution of China's research and development (R&D) and industrial systems, with particular attention to the latter's still dominant state and collectively owned enterprises (COEs), seen as the key components of the country's overall national system of innovation (NSI).

An "effort" is needed in a relatively poor country in order to "catch up" with more advanced ones because automatic market mechanisms do not lead to international growth convergence.[1] International convergence appears to be a phenomenon limited to clusters of highly integrated economies at not too distant levels of overall development,[2] and/or to the cases of individual countries, or groups of countries which have implemented strong and proactive accumulation and growth-enhancing economic strategies (UNCTAD, 1997, 1998).[3]

Therefore, even taking into account the relevance of exogenous constraints, the appropriateness of national development strategies carries a decisive weight, at least for those developing countries which, due to a set of historical and structural factors, are in fact endowed with an appreciable degree of autonomy and self-determination. These countries must open up and rely to a large extent on the progressive absorption of foreign technology, mainly from the developed countries of the North, but this goal cannot be achieved simply as a byproduct of economic liberalization.[4] North-South R&D spillovers

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[1] For "growth convergence" we mean a state of affairs in which poorer countries grow faster than rich ones, so that their per capita incomes eventually converge towards the same level. In relation to the concept of "conditional convergence" (see footnote 2), the aforementioned type of convergence might be called "absolute convergence". Barro and Sala-i-Martin (1995a: 420), referring to an ample data set on real per capita growth rates in different countries, show that the absolute convergence hypothesis "fares badly in terms of the cross-country data … for 119 countries, the growth rate from 1965 to 1985 is basically unrelated to the log of per capita GDP in 1965 … . Thus, any hope of reconciling the convergence hypothesis with the data has to rely on the concept of conditional convergence".

[2] Barro and Sala-i-Martin (1995b) developed the concept of "conditional convergence", according to which the coexistence of a complex series of conditions is a necessary condition for convergence to occur. Conditional convergence appears to have occurred among the relatively similar OECD countries.

[3] A number of observers have attempted to explain the lack of convergence focusing on structural factors, among them human capital (Barro and Sala-I-Martin, 1995a, b) and externalities (Lucas, 1990). Others individuate in the very shallow division of labour (*à la* Smith) the origin of the underdevelopment trap, in which both wages and the rate of profit are low, and thus no foreign capital is forthcoming and no movement towards a higher level steady state takes place (Rodriguez-Clare, 1996). A shallow division of labour is tantamount to a lack of diffusion of those roundabout production methods typical of developed economies, which to be implemented need the complementary presence of many specialized physical inputs as well as intermediate goods difficult or costly to acquire in the South, which are only imperfectly tradeable. *A fortiori*, modern production requires a series of producer services (banking, auditing, machine repair, etc.) and infrastructures, which are of course non-tradeable (Porter, 1990). Moreover, local institutions might also be inadequate, and amenable to change only over a relatively long period of time.

[4] Neoclassical theory would, in principle, predict higher-than-average rates of return to capital in poorer countries, according to their lower K/L ratios. Capital should hence flow abundantly towards developing countries, leading to very high growth rates. In practice, this is not necessarily the case, due to the absence in these countries of a host of complementary conditions, which constitutes the essence of underdevelopment. As a matter of fact, in the long run, the classical assumption on the uniformity of the rate of profit tends to hold also at the international level (Rodriguez-Clare, 1996).

do occur through international trade,[5] but it is not trade per se which brings about the transmission of knowledge. The diffusion of R&D results across borders is more partial and slow than simplified neoclassical assumptions might allow (Lichtemberg, 1992), consistently with the common founding of high social returns to R&D at the national level. The diffusion of knowledge through trade depends to some extent on factors belonging to the most advanced trade partners, as some firms are more willing than others to transfer knowledge to their partners from developing countries. However, a set of endogenous factors typical of each country, which jointly constitute its absorptive capacity, carry a far heavier weight.[6]

The concept of absorptive capacity was pioneered by Cohen and Levinthal, who applied it to the analysis of the optimizing strategy of a firm in a competitive national market, but can be readily extended to a developing country's efforts to enhance its efficiency in the task of keeping up with externally generated science and technology (S&T) advances. Cohen and Levinthal (1990) define absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it and apply to commercial ends… [which is] … largely a function of the level of prior knowledge…" and argue that it is "critical to its innovative capabilities" (*idem*: 128). Therefore, prior knowledge has to be seen not only as a stock of information, but also as a "set of learning skills" (*idem*: 130). An organization's absorptive capacity goes beyond the abilities of its individual components, as there are aspects of absorptive capacity which are distinctly organizational and depend not only on the firm's interface with the external environment but also on "transfers of knowledge across and within subunits" internal to the organization itself" (*idem*: 132). In the case of a firm, absorptive capacity, along with other mostly informal activities, depends on its R&D effort, because "R&D not only generates new information, but also enhances the firm's ability … to identify, assimilate and exploit knowledge from the environment" (Cohen and Levinthal, 1989: 569). When the concept is extended to a country, absorptive capacity is to be considered a function of several structural and policy-related domestic factors, among which the availability of human capital (measured, for instance by the rate of literacy, and the number of technicians and engineers), besides, of course, the existence, extent, effectiveness and flexibility of a national R&D and innovation system (Keller, 1996).

The concept of *social*[7] or *national* absorptive capacity is closely related to that of an NSI. The notion of NSI was introduced in contemporary debate by Freeman (1987), who defined NSI as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Archibugi et al., 1999: 1), and developed by Lundvall (1992) and Nelson (1993). According to Chesnais (1995), the notion of NSI encompasses a set of interactions among technology, trade and growth, "so as to suggest that the performance of national economies depends on the manner in which organizational and institutional arrangements and linkages conducive to innovation and growth have been permitted to thrive in different countries" (Dosi, 1999: 23).

A country's NSI may be seen as an organization of a higher hierarchical level than that of the firm, and to which the same concepts can be applied. The wider the gap between a country's technological

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5 One of the main transmission channels is the importation of machines from developed countries, which acts as vectors of the knowledge produced by the R&D carried out in the North (Bayoumi et al., 1999).

6 It has been argued that, if a developing country's absorptive capacity is too weak, trade with more advanced countries can lead to an unfavourable divergence in growth rates, which actually widens the technological and economic gap over time (Feenstra, 1996).

7 Abramovitz (1989: xviii, 377) was among the first to recognize that the exploitation of the catching-up potential stemming from backwardness was related to a country's "social capability".

level and that of the world leaders, the more its indigenous R&D and related formal and informal learning efforts will be geared to absorb externally generated knowledge rather than to produce truly "new" knowledge. Moreover, the acceleration of the globalization process worldwide, with the increase in the speed and diffusion of information flows and the strengthening of international competition forces, makes it even less feasible than in the past for any single country to pursue an idiosyncratic technological path of its own, isolated from external S&T trends. For semi-industrialized countries, these factors further strengthen the strategic decisiveness of enhancing their nationwide absorptive capacity. Countries attempting to keep up must strive to earmark more resources to R&D and related activities, on the one hand, and to improve the functioning of their S&T apparatus and its interactions with productive enterprises, on the other hand, in order to facilitate the transfer of knowledge among the various subunits of their NIS.

As this concept of NSI, like that of technical progress, is a broad one, comprising seemingly distant structures such as the national R&D system and the industrial sector, this paper will also discuss some aspects of the reform of China's SOEs. Most SOEs are expected to be progressively de-statized in different ways (mergers with other SOEs or COEs,[8] sales to TNCs or private capitalists, and outright bankruptcy and liquidation). A core group of about 1000 large SOEs (those most capitalized and technologically advanced) is to be strengthened and prioritized in order to turn them into modern world-class enterprises with the potential for reaching and keeping the technological edge. Particular attention will be dedicated to the interaction among the different layers of socialist property rights relations, their implications for corporate governance and managers' and workers' incentives, and their ultimate impact on technical progress and more generally on the attainment of an intensive path of sustained economic growth. As a tool of this analysis, a distinction will be made between the concepts of "market orientation" and "market compatibility". An activity is "market-oriented" if it is aimed at realizing a profit by means of a relatively straightforward transformation, distribution, or servicing process based almost exclusively on information stemming from prices and other signals emanating from existing markets. Conversely, by the term "market-compatible" we refer to an economic activity which, even if it is not necessarily directly geared to selling in presently existing markets, is nevertheless oriented towards the creation of future market competitiveness in advanced sectors via a more roundabout and long innovation and production process.[9]

The above observations apply to all relatively underdeveloped countries. This paper however, focuses on a very particular developing country, China, which is unique in its size and the enormous development potential of its reforming socialist market economy. The term "socialist market economy" is employed officially by the Chinese government and is consistent with the definition used here of "socialist" – which is a rather narrow and technical one, and which relates exclusively to the domain of property rights. For "socialist" property rights, or "socialist" ownership of means of production, or even "socialist" production relations, we simply mean that the a commanding share of property rights,

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[8] The COE industrial sector comprises township and village enterprises (TVEs), plus a number of very small enterprises at below village level. As this study focuses on not-so-small industrial firms, the terms COE and TVE refer in practice to the same group of industrial firms.

[9] A sound "market-compatible" activity must be based on realistic and informed forecasts on the likely evolution of market and technology trends. Of course, large private firms in capitalist countries routinely engage in market-compatible, but not directly market-oriented, activities as part of their overall profit-maximizing strategy. For instance, most private R&D activities tend to be market-compatible rather than directly market-oriented.

particularly substantial control on the surplus,[10] is bestowed on one or more non-private institutions, be they central or local government bodies or other relatively autonomous institutions such as banks, financial companies, universities, R&D centres, and others.[11] As such, the definition "socialist" is by itself inappropriate vis-à-vis other concepts and values often associated with socialism, such as justice, egalitarianism, planning, freedom or the lack of it, and may be easily interchanged with the term "public".[12]

II. BASIC FACTS ABOUT CHINA

A. Fast GDP growth

At the time of the foundation of the People's Republic of China in 1949, the bulk of its population was constituted of destitute and illiterate peasants. The infrastructure was dilapidated and little was left intact in the few pre-war industrial enclaves. Since then, China has followed a rapid, if highly unstable, development path. By the mid-1970s, the country had undergone a vast, albeit autarkic and relatively inefficient, process of industrialization. Life expectancy and infant mortality indexes had experienced dramatic improvements. A large majority of the population has become literate and its basic needs in terms of food, health and education met. These achievements are largely due to the fact that China is one of the most egalitarian countries in the world.

Since the inception of bold agricultural reforms in the late 1970s, followed by successive waves of reforms in the industrial sector during the 1980s and 1990s, the overall rate of growth and, broadly speaking, economic development have accelerated markedly, making China the fastest growing economy in the world. GDP growth has averaged over 10 per cent in the latest two decades, a performance not only unrivalled by any other large country in the last quarter of the XXth century, but also with very few, if any, precedents in the course of modern economic history. Private consumption had also experienced very fast expansion, improving enormously the material well-being of most urban and rural Chinese, even taking into account the multiple social and environmental drawbacks of the new economic path (see table 1). The proportion of the population considered as absolutely poor fell from over 50 per cent in 1978 to 8 per cent in 1997, according to national estimates, and from over 60 per cent to 22 per cent, according to the World Bank (OECD, 2000).

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[10] In recent orthodox literature, the word "residual" is often preferred to the classical term "surplus". They are used interchangeably in this paper.

[11] Terms such as "commanding share" or "substantial control" do not always correspond to a specific percentage share of formal ownership rights; thus, on one hand, they should be interpreted in a rather qualitative and flexible way, and, on the other, to be employed meaningfully, they sometimes require a thorough knowledge of the specific reality of a firm or other institution.

[12] The term maintains a more direct relation with the question of income distribution. Socialist ownership of the means of production in principle allows public institutions, such as national and local governments, and a higher degree of freedom in influencing income distribution with respect to private property. Thus, "although often viewed as necessary for economic development in its earlier stages, public ownership in China is also seen as necessary to preserve social equity and other values; in that sense it is an objective … and not simply a means of reform. These values are also reflected in … a preference for collective ownership forms in the non-state sector" (OECD, 2000: 10). The effective realization of public ownership's potential advantages with respect to equity is dependent upon the relative priority attached to distributional goals by policy-making institutions, as well as upon a host of specific circumstances typical of any country in a given developmental stage (see subsection II.C and footnote 75).

Table 1
China: basic economic indicators, 1980–1999
(Average annual percentage growth)

	China		*East Asia and the Pacific*		*World*		*Rep. of Korea* [a]	
	1980–89	*1990–99*	*1980–89*	*1990–99*	*1980–89*	*1990–99*	*1980–89*	*1990–99*
GDP	10.1	10.7	8.0	7.4	3.2	2.5	9.4	5.7
Exports	19.3	13.0	11.1	12.6	5.2	6.9	12.0	15.6
	1980–99		*1980–99*		*1980–99*		*1980–99*	
Private consumption (per capita)	7.2		5.6		1.3		6.5	

Sources: World Bank (2000a).
a: Second fastest growing economy.

B. Rapid export expansion and upgrading of exports

Export growth was much faster than GDP growth, transforming the China's economy from a quasi-autarkic one into a very internationally integrated one, with extraordinarily high trade ratios for a country that size (tables 1 and 2). China's export also underwent a process of increasing upgrading and diversification. The share of primary goods in total exports declined sharply, while that of manufactures increased from 50 per cent in 1980 to almost 90 per cent in 1998. The subcategory of relatively advanced manufactures constituted by machinery and transport equipment increased its share of manufactured exports from 9 per cent in 1980 to 27 per cent in 1998 (table 2).

China's exports are now more diversified than those of any other developing country, and specifically than those of the Republic of Korea, Taiwan Province of China, the United States and Japan (table 3) Only the Netherlands, Italy and the Czech Republic exhibited a lower Hirshmann export concentration index in 1997 (UNCTAD, 2000a, table 4.5).

C. Relatively slow improvement in social indicators and mass education[13]

Thanks to its exceptional growth record, China's per capita GDP climbed from abysmally low levels to more than $3000 (in purchasing power parity terms) in 1998 – not much lower than in countries like the Philippines and Cuba (see table 4). Taking into account the social progress already realized up to the late 1970s, however, social advancements so far since the inception of the reforms have been substantial,

[13] All data in this subsection are from tables 4 and 5. The sources for these tables are UNDP (2000) and UNCTAD (2000a). While the most basic indicators, such as those on life expectancy and the literacy rate, pose no interpretation problems, others – such as the Human Development and Human Poverty Index – have been produced according to a methodology specifically elaborated within the framework of the preparation of the *Human Development Report*, which is inevitably ad hoc and subjective to a non-negligible degree. Therefore, especially in the context of this paper, which is focused on very different issues pertaining to the sphere of technology and industrial organization, these social indexes are reported only as very broad background references.

Table 2
Basic data on trade and export structure: China and other countries

	China	*India*	*United States*	*Japan*
		A. Trade data, 1999		
Export fob (US$ billions)	989	435	9,299	4,351
Exports + imports/GDP	0.36	0.10	0.18	0.16
Exports/GDP	0.20	0.09	0.07	0.09
		B. Evolution of China's export structure		
		1980	*1994*	*1998*
Primary goods		50	16	11
Manufactured goods		50	83	89
• of which machinery and transport equipment		9	18	27

Sources: EIU (2000); SSB (2000).

but less than fully satisfactory, as evidenced by their comparison not only with other developing socialist countries like Cuba and Viet Nam, but even with several capitalist developing countries. Most observers agree on ascribing this phenomenon mainly to the deterioration in income distribution, which has become more unequal[14] than in the past, and to the decline of the traditional social services, especially in rural areas.[15]

Actually, improvements in life expectancy, the infant mortality rate, and more controversial indicators elaborated by UNDP such as the Human Poverty and Human Development Indexes rank China high among all developing countries, but not among the small group of socially best performing countries. Consistently, the difference between China's Human Development Index and GDP per capita ranking – which may be seen as a rough proxy of a country's ability to translate economic growth into social progress – is positive (a better-than-average performance), but lower, for instance, than in Sweden and Cuba (see table 4).

Finally, we briefly refer to the education-related social indicators, which are of special interest for the purposes of this study. Apart from its obvious value as an ultimate goal of development, education is also a means to increase a country's human capital, and thus its ability to generate and absorb technical

[14] Income distribution in China is still rather egalitarian, compared to most other developing countries. It should also be taken into account that the very size of China and its extraordinary pace of structural change would tend *ceteris paribus* to imply a more unequal distribution pattern than in smaller and slower growing countries, for purely statistical reasons. A UNDP estimate of one of many existing income distribution indicators is reported in table 3, along with those of other developing countries. On income distribution see also footnotes 12 and 75.

[15] To determine to what extent this relative social deterioration should be considered an inevitable trade-off for the achievements of the economic reforms would constitute a very complex and debatable task, which goes beyond the scope of this paper.

Table 3
Export concentration indexes [a]

	1990		*1997*	
	Concentration index	*Number of commodities exported*	*Concentration index*	*Number of commodities exported*
China	0.080	229	0.068	233
Republic of Korea	0.103	211	0.145	220
Taiwan Prov. of China	0.086	216	0.119	223
India	0.142	207	0.122	221
United States	0.071	226	0.078	226
Japan	0.216	230	0.130	233

Sources: UNCTAD (2000a).
a The table presents a normalized Hirshmann index, with values ranging from 0 (minimum concentration) to 1 (maximum concentration).

Table 4
GDP per capita and social indicators [a]

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	GDP per capita (PPP US$)	*Income distribution* [b]	*Infant mortality rate* [c]	*Life expectancy*	*Progress in life expectancy* [d]	*Human Development Index rank*	*HDI rank minus GDP per capita rank*	*Human Poverty Index rank*
China	3,105	7.9	38	70.1	6.6	99	7	30
Other countries:								
Brazil	--	--	36	--	--	--	--	--
Costa Rica	5,987	9.6	--	--	--	--	--	--
Cuba	3,967	--	7	75.8	--	--	40	3
Kyrgyzstan	--	--	--	--	--	98	--	--
Mexico	--	16.2	--	--	--	--	--	--
Philippines	3,555	--	--	--	10.5	--	--	--
Rep. of Korea	--	--	--	--	--	31	--	--
Sweden	--	--	--	--	--	--	15	--
United States	29,605	--	--	76.8	--	--	--	--
Viet Nam	1,207	5.6	--	--	--	--	--	--

Sources: UNDP (2000).
a For 1998, except column (5).
b Share of income: richest 20 per cent/poorest 20 per cent.
c Per 1000 live births.
d 1995–2000, minus 1970–1975.

progress. The adult literacy rate (82.8 per cent in 1998) in China is higher than in most other developing countries, but lower, for instance, not only than in Cuba, but also than in much poorer Viet Nam and in the Philippines. The secondary age group enrolment ratio in education also leaves room for improvement. Public expenditure on education in the mid-1990s, as a share of GDP, was lower in China than in the Republic of Korea and India. The youth literacy rate, however, is very high, suggesting that a massive expansion of primary school education took place in the 1980s and 1990s (see table 5).

Table 5
Education indicators
(Percentage)

	Adult literacy rate [a] *(1998)*	*Youth literacy rate* [b] *(1998)*	*Secondary age group enrolment ratio in education* [c] *(1997)*	*Education index (1998)*	*Public expenditure on education (GDP 1995)*
China	82.8	97.2	70.0	0.79	2.5
Other countries:					
Cuba	96.4	-	-	-	-
India	-	-	-	-	3.4
Mexico	-	96.6	-	-	-
Nigeria	-	-	-	-	0.9
Philippines	-	-	77.8	0.91	-
Rep. of Korea	-	-	-	-	3.7
United States (1994)	-	-	-	-	5.4 [d]
Viet Nam	92.9	-	-	-	-

Sources: UNDP (2000); UNCTAD (2000a).
a Percentage of age 15 and above.
b Percentage of age 15 to 24.
c Percentage of relevant age group, adjusted.
d In 1994.

III. THE TWO-PRONGED POLICY APPROACH TOWARDS FDI

A. The limited potential of FDI per se as a technology conveyor

The creation, acquisition and diffusion of innovation is the product of the interaction of foreign and domestic factors. Among the former, especially in developing countries, the role of technology transfers from TNCs through FDI and other channels is of course very important. It will be argued, however, that the technology transfers to be expected from most of the FDI presently taking place in China should not be overestimated, and the benefits attainable from "high-technology" foreign investment, as well as from other forms of cooperation with TNCs, are contingent on the upgrading of domestic absorption capacity via the development of the S&T system and the modernization of industrial enterprises.

Foreign direct investment can allow financially stripped developing countries to increase their investment rates, thus fostering employment and economic growth. FDI contribution to technical progress is more controversial. According to theory, FDI can advance economic growth in the host economy through global technology transfers and domestic knowledge spillovers, fostering product and process innovations, introducing new management practices and contributing to the building of human capital (Knell and Radosevic, 2000). Coe and Helpman (1995) show that international R&D spillovers play an important role in contributing to productivity growth across industries. Under favourable circumstances, R&D spillovers can arise from trade and FDI flows, but they are not an automatic byproduct of either. As pointed out, for instance, by Estrella Tolentino (1993), there is a threshold in the level of domestic technological competence, below which FDI might even stifle domestic competition and thus provoke underdevelopment, dependent development, and technological decline in low-income countries which lack domestic R&D and technological capacities. Conversely, if local technological competence is adequate, a virtuous cycle can be put into motion. Thus, the assimilation of outside technology is heavily dependent upon the development of domestic technological capabilities (Young and Lan, 1997), and host country factors are crucial in the attempt to enact technology transfers from foreign investors in developing countries. Among these factors, of course, the role of government, and in particular its "macro-organizational strategy" (Buckley et al., 1992), are of great importance.

Especially where strategic and high technology sectors are concerned, "the outcomes of FDI depend significantly on how well a host economy bargains with international investors … a passive, *laissez-faire* approach is unlikely to be sufficient because of failures in markets and deficiencies in existing institutions" (UNCTAD, 1999b: xxxii–xxxiii). Unfortunately, most developing countries are at a great disadvantage vis-à-vis TNCs in this domain, owing not only to the ever increasing technological and informational gap between the centre and the periphery worldwide, but also to the self-inflicted wounds caused by the excesses of liberalization and the unwise implementation of non-discretionary incentive policies.

B. The boom of FDI flows to China and the quantitative prevalence of low-technology investments

Among developing countries, China has been exceptionally successful in attracting FDI, accounting for about one third of inflows to all developing countries in 1997–1998 (see table 6). Moreover, as opposed to the rest of the developing world, most of this investment has been of the greenfield type, i.e. real new investment adding to the productive capacity of the country, instead of representing essentially a change of ownership[16] following the privatization of previous SOEs (UNCTAD, 1999a).[17]

The contribution of FDI to the overall growth of the Chinese economy has been positive and substantial. The share of FDI in total fixed investment has exceeded 14 per cent, on average, during the period 1995–1997, which is very high, even if it represents less than one seventh of the overall

[16] Mergers and acquisitions are usually followed by restructuring exercises which can eventually benefit the host country, but do not by themselves add to its productive capacity.

[17] While absorbing a huge amount of FDI, China has managed so far to avoid being flooded by large and unstable financial capital inflows, which have contributed to crises in many developing countries (Boratav et al., 2000).

accumulation effort of the country (UNCTAD, 1999b, Annex table B5,[18] and table 6 below). FDI has been adding not only to sheer capacity growth but also, selectively, to the acquisition of foreign exchange and to employment.[19]

Table 6
FDI inflows to China

	1988–93 (average)	*1997*	*1998*	*1999*
FDI inflows (US$ billions):				
• China	8.8	44.2	43.75	40.4
• All developing countries	46.9	178.8	179.5	207.6
• Average South Asia, East Asia and South-East Asia	27.1	93.5	87.2	96.1
FDI/gross fixed capital formation (percentage):				
• China	6.4	14.6	12.9	--
• Average developing countries	4.6	10.8	11.5	--
• Average South Asia, East Asia and South-East Asia	5.5	9.8	10.5	--

	1980	*1995*	*1998*
FDI stocks as a percentage of GDP:			
• China	3.1	19.6	27.6
• Average developing countries	5.4	13.4	20.0
• Average South Asia, East Asia and South-East Asia	7.9	15.0	23.3

Sources: UNCTAD (2000b).

The government's strategy vis-à-vis foreign investors appears to recognize the existence of a fundamental difference between low-tech FDI, carried out mainly by expatriate Chinese and firms from the East Asian region, on one hand, and high-technology FDI, carried out by large TNCs from the West and Japan, on the other hand.

A case study (Young and Lan, 1997) carried out in Dalian, one of China's 14 economic and technology development zones, is very illustrative of a scenario which is probably common to most FDI ventures of the low-tech type, which are by far the most numerous. The study shows clearly that

[18] UNCTAD (1999b) might have overestimated the relative contribution of FDI to capital accumulation in China. According to official Chinese sources (State Statistical Bureau), FDI contribution to total fixed assets investment was just over 10 per cent on average for the three peak years 1995–1997, and declined thereafter (Ge, 2000, table 5).

[19] China's openness to FDI contrasts markedly with Japan's and the Republic of Korea's more closed policy attitude towards foreign investors during comparable stages of their catching-up process (Hsieh, 1994).

technology transfer through FDI in Dalian is fairly low. There is little local R&D and thus little absorptive capacity, and there has been no effort to attract R&D into FDI firms. To a large extent, this was to be expected, given the level of technological competence in the bulk of China's industry, outside the small islands of technological and scientific excellence confined to the main R&D centres and to a reduced number of advanced large SOEs and joint ventures. Moreover, most foreign investors are interested in exploiting the availability of cheap and abundant labour and of a suitable infrastructure in order to set up low-tech ventures in mature light industrial sectors (mainly textile and apparel), aiming at realizing quick profits.[20] Moreover, as a result of excessive decentralization, incentive-based competition among different localities to attract FDI is probably too fierce, with pledgings by foreign firms being poorly specified and usually limited to export targets rather than technology transfers. In fact, a more sophisticated technology policy approach would be hard to implement at a very decentralized level, taking into account local planning and research capabilities, on the one hand, and the short-term horizon of foreign investors, on the other hand. In sum, Dalian, like most FDI-intensive areas, is doing well in terms of exports, profits and employment, but is advancing modestly in terms of technology, in spite of the clear awareness of Chinese managers of the importance of this issue.

The Dalian experience is consistent with the results of an econometric study carried out on a larger sample of manufacturing firms in eight Chinese cities. This study shows that, while competition from more advanced foreign firms contributes to intensifying Chinese enterprises' own training and learning efforts, FDI per se does not significantly contribute to technology transfers and to the productivity growth of local firms (Kinoshita, 1999).

These findings are not surprising, taking into account that most Chinese COEs and many non-strategic SOEs behave to a large extent like small or medium privately owned firms in other developing countries. Their approach tends to be strongly market-driven but short-sighted and lacks a long-term technology strategy. As a result, their cooperative relations with foreign investors from more advanced countries, and especially with TNCs, is uneven, albeit mutually profitable. Foreign counterparts tend to have better long-term strategies and enjoy a significant degree of technological monopoly. The bargaining power pattern determined by the market in the absence of effective industrial policies is such that foreign investors reap most of the benefits, at the expense of local firms and workers.[21] In China, this type of FDI has fulfilled and still plays a positive role for targets such as GNP growth, exports and employment, and to a certain degree it contributes to spreading contacts with advanced Western productive, managerial and financial technologies. But to base future technological progress only on this passive form of technological

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[20] According to Young and Lan (1997: 676), flaws in the government policy carry part of the blame, as the main thrust of policy makers, particularly during the low phases of the economic cycle, has been that of offering very generous but poorly targeted incentive packages, with the "effect of encouraging the quantity rather than the quality of FDI". To some extent excessive interferences in regulating foreign firms' activities – such as in the ceilings imposed on output prices and on ownership shares in joint ventures with local firms – may actually discourage the development of local linkages and act as brakes on technology transfers.

[21] It is rationally in the interest of TNCs to play firm against firm, locality against locality and country against country in order to obtain maximum advantages from cheap labour and market control, while releasing to a minimum degree their technological monopoly: "As commercial enterprises, TNCs in principle do not have an interest in transferring knowledge to and supporting innovation in foreign affiliates …" (UNCTAD, 1999b: 219). The behaviour of foreign investors is independent of the property status of local firms, as far as the latter act in a decentralized fashion obeying chiefly the target of profit maximization, even if the latter is partially tempered by local employment and other valuable social objectives, rather delinked from the goal of fostering technological progress nation-wide in the long term.

absorption would clearly be unrealistic. Other policy instruments are warranted.[22] Low-tech FDI, besides generating foreign exchange, can help to improve marginally overall marketing and the technological environment, but its main role with respect to goal of the technical progress should be that of complementing, supporting and contributing to finance other, more centralized and strategic paths to accelerated technological development.

C. China's bargaining position vis-à-vis TNCs and the role of absorptive capacity

A crucial component of the "high" layer of the overall Chinese technological strategy is the discretionary and centralized cooperation with top TNCs from advanced capitalist countries. China's large market and its independent political position[23] potentially allows for a considerable negotiating power vis-à-vis major Western TNCs. This power, if properly utilized, can lead to ambitious high-technology joint programmes with a high potential for the acquisition and mastering of foreign technology and for achieving positive interactions and feedbacks with the indigenous S&T system. Such a centralized, planned S&T strategy, carried out through quasi-administrative, albeit flexible instruments such as long term programmes, priority projects, and joint ventures in high-technology sectors, is suited for targeting the most advanced segments of the technological and scientific spectrum.[24] It is also compatible and in fact complementary with the partial flexibilization, marketization and commoditization, of (mainly domestic) technology trading and transfers, which is suitable for the medium and lower levels of the S&T range (see section IV).

This strategic component constitutes the opposite of a *laissez-faire* policy stance – which, on the contrary, prevails in the trait offered to those mostly Asian firms which provide the bulk of FDI in quantitative terms. In China, it applies to an ample gamut of instruments traditionally considered as part of the domain of industrial policies and to the negotiating power of central government bodies, to an extent matched by few other large developing countries. Moreover, at odds with the trend prevailing in most of the developing world, Chinese planners rely heavily on the maintenance and strengthening of an advanced core of state-owned industries as a key instrument to engage in joint high-technology ventures along with TNCs (see section V).

Consistently with Cohen and Levinthan's theory referred to in the introduction, however, the viability of the strategic component of China's approach to FDI is contingent on the continuous development of its absorptive capacity, as a precondition to achieving effective technology transfers from TNCs investing

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[22] "There is role for policy in upgrading capabilities to optimize the transfer of TNC technology … there is a continuum of strategies with regard to the transfer, generation and diffusion of technology" (UNCTAD, 1999b: 219). S&T strategies, which rely on several institutional arrangements and multiple, non-mutually incompatible instruments and programmes, are always to be preferred to one-dimensional ones. The severe risks implied by the alternative choice of a completely centralized technological strategy are well illustrated by the Soviet experience. The USSR achieved some great technological achievements, such as the creation of a modern aerospace and military industry. The costs of following this over-centralized and autarkic technological pattern, however, were enormous, as it led to losing touch with the market-driven, more advanced technological avenues embraced by the already far more advanced Western countries. Many fatal scientific and technological mistakes occurred due to the country's isolation and to the lack of long-run market compatibility of the Soviet NSI.

[23] National autonomy is enhanced by the fact that, as opposed to most other developing countries, in China political and economic power is not concentrated in the hands of a post-colonial bourgeoisie structurally dependent on its subordinate relation with transnational capital.

[24] Conversely, a major trade-off of China's entry in the WTO is likely to be constituted by the partial erosion of its negotiating power with respect to TNCs.

in the country. As China is not the world technological leader, R&D activities carried out inside industrial enterprises, in universities and in specialized research centres, must be geared to a large extent towards the enhancement of learning and adaptive capabilities, rather than towards the generation of innovations which are absolutely "new". The evolution of the R&D system examined in the following section should therefore be seen as the progressive refinement and improvement of China's ability to understand and master already existing knowledge and to develop it to suit the needs of national technological and economic upgrading.

IV. THE EVOLUTION OF CHINA'S R&D SYSTEM

A. The change in China's technological culture and the commercialization of small-scale R&D activities

Traditionally, in China different S&T policy cultures (which Baark, 1992, identifies as bureaucratic, entrepreneurial and academic) have been coexisting with difficulty, resulting in a certain degree of fragmentation. The influence of the bureaucratic and academic cultures and the resulting tensions and contradictions have limited the capacity to exploit the potential for feedback and backward linkages between productive enterprises, on one hand, and the S&T system, on the other hand. The reforms initiated in the mid-1970s brought about a change in the ideological climate also in this domain. Hence, by the early 1980s, as opposed to most of the Maoist era, the prevailing view on S&T was relatively non-ideological and very favourably disposed towards the scientific method: "science and technology were seen as the centrepiece of China's economic modernization strategy … (scientists) were asked to criticize 'superstition' … 'feudalism' … and the 'feudal leftist' legacy of the Maoist period …" (Miller, 1996: 184). The government recognized the mutual interdependency of scientific, technological and economic development, and acknowledged that a multi-layered technological structure would persist in China for a long time yet. It also stated that the purpose of research on the technology of industrial and agricultural production was to foster the development of cheaper and better commodities, and therefore it had to be carried out to a large extent inside, or in cooperation with industrial enterprises, with a view to help bridging the traditional gap between R&D institutions and productive firms.[25]

Yet, the institutional legacy in China at the beginning of the reform era was constituted by a Soviet-type S&T planning apparatus, with its elements of strength and weakness. Its pillars were constituted by a central research organization (the Academy of Sciences) and a system of military and sectoral R&D institutes, with a high degree of concentration on a few, specific, defence-related research projects. The realization that the main drawback of this defence-centred system was the failure to transfer effectively to productive enterprises practical new knowledge prompted the implementation of a series of major reforms,[26] aiming at encouraging the commercialization of research and its integration with production. According to the officially endorsed theory, as China was a "socialist commodity economy", the results of R&D (i.e. designs, prototypes and know-how in general) were actually commodities as well, and as

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[25] Yu (1999: 10–11). These policy lines were originally elaborated by the China State Science and Technology Commission and eventually endorsed by the State Council in 1981.

[26] An important endorsement of reforms came with a central committee resolution on the reform of the S&T system in 1985.

such it was legitimate for them to be traded among different agents. Budget allocations for most R&D centres were reduced,[27] while their managerial and, partly, financial autonomy was enhanced, as they were encouraged to sell their knowledge-intensive outputs. Various forms of markets and market-like institutional arrangements to facilitate trade in "intellectual commodities" were thus established. Technology trade has expanded fast since the 1980s.[28]

However, low prices for technology items and the fact that most technical purchasers were COEs and other relatively small firms appeared to show that SOE demand for technology was below full potential. Partly to overcome this problem, horizontal cooperation between enterprises and research institutions was encouraged, with initiatives coming from both sides. Consequently, not only did major industrial enterprises create or strengthen their research departments, but also a new breed of small, independent, technology-based firms started to spread, originating from the core of the traditional R&D institutions set up by the state. Initially, they were all locally or state-owned, established by universities or research centres; a typical example, which would later show great development potential, was the founding of "electronic street" firms in Beijing. The present ownership structure of their physical assets is very diversified, but the strength of these high-technology firms consists in the scientific and technological excellence of their limited workforce, in their entrepreuneurial vocation and market-orientation, and in their flexibility in adopting aggressive and stimulating working and compensation arrangements.[29] The commercialization of important sectors of the R&D apparatus, like similar market-oriented developments in China and elsewhere, however, could only represent a partial solution.[30] The close relations between R&D, production and markets constitute very positive developments, but they could be somewhat counterbalanced by the risk that scientists might end up being too constrained by short-term market pressures, spending most of their time and efforts acting as traders of second-hand imported technology than as real scientists. The new commercial-oriented firms appear in fact to be effective in delivering practical, innovation-oriented, S&T projects, but they focus essentially on medium-level S&T fields, which do not need a major centralized commitment of resources and the planned coordination of several institutional agents. The partial commoditization of R&D thus appears to fulfil an important task, but it does not eliminate the need for a strengthened centralized R&D and S&T system focusing on the most advanced technological areas (Suttmeier and Cao, 1999).

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[27] The "financially virtuous" character of these reforms, which aimed at improving the efficiency of R&D structures using at least as much the stick as the carrot, explained to some extent why important results could be achieved with limited resources. As is the case with all exclusively efficiency-minded policies, such an approach was bound to show diminishing returns. Hence, from the beginning it was complemented by other initiatives, and by the mid-1990s it was progressively substituted by a more bold R&D policy.

[28] Science parks also proliferated, the first having been established by the Academy of Sciences in Shenzen. They tend to be established in the framework of programmes sponsored at different governmental levels.

[29] See Yu (1999: 199–207). It should be borne in mind that the success of this type of enterprise and its social acceptability are related to its elite, vanguard character, and that its model cannot be naively transferred, for instance, to the bulk of reforming SOEs.

[30] The increasing commercial orientation of scientific laboratories and the implementation of strategic S&T programmes are not the only avenues through which China is fostering technical progress. Other important channels include the acquisition of foreign technology via joint venture, licensing and coproduction arrangements, the promotion of venture capital industry to channel equity investment into new technology start-ups, and the encouragement of a larger role for R&D in industrial enterprises (mainly large SOEs) (Feigenbaum, 1999).

B. The quantitative and qualitative growth of the national R&D system

In the most advanced countries the core of the R&D and of most downstream innovation-generating activities has been shifting increasingly towards large private corporations and has become progressively more market-driven, although the direct and indirect role of the state is still far from negligible (OECD, 1998: 294). Conversely, in less advanced countries at an intermediate level of development[31] the role of national S&T policies and of centralized R&D and innovation systems can be of paramount importance.

Among developing countries, China is one of the few in a position to engage effectively in planned nationwide R&D endeavours. Even if only a tiny fraction of the young Chinese reach graduate and postgraduate education, university enrolment is sizeable in absolute terms, having increased from 2 million in 1990 to over 3 million by the late 1990s (*China Statistical Yearbook*, 2000). China has a large number of good quality scientists and engineers and a long experience in high-tech programmes, which have been carried out since the 1950s[32] mainly for military purposes.[33] In the late 1990s, almost 3 million scientists, engineers and other personnel were engaged in China in S&T[34] (tables 7 and 8), corresponding to more than 40 per cent of the total for all developing countries and almost 10 per cent of the world total (UNCTAD, 1999b). While the number of S&T institutions has decreased since the mid-1990s, according to the policy goals of rationalizing and focusing more sharply the research effort, the number of scientists, engineers and other personnel engaged directly in S&T activities has been steadily increasing, as has the funding for research and, marginally, the R&D/GDP ratio. Beyond those involved in S&T proper, many other professional workers (over 20 millions in 1999) are engaged in various engineering and teaching activities in SOEs and other institutions. This figure almost duplicates that of 1990 and quadruplicates that of 1980 (table 7). In relative terms (number of scientists and engineers in R&D per million population; R&D spending/GDP) China's R&D effort ranks still far lower than that of the Republic of Korea and Taiwan Province of China, but it is higher on average than that of Latin American countries (table 10; see also UNCTAD, 1999b).

In a complementary fashion with respect to indigenous R&D efforts, imports of machines are another avenue through which a developing country can accede to the world's technology pool (see footnote 5). China's imports of machines and transport equipment increased threefold in the 1980s and over fourfold in the 1990s (table 11).

Data on R&D outputs appear to show a more marked improvement than those on R&D inputs, suggesting that the efficiency-enhancing reforms carried out since the 1980s have been rather successful.

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31 Most developing countries are simply too poor in terms of human and non-human capital, as well as too institutionally underdeveloped, to engage in even quite modest state-sponsored R&D and S&T programmes. Moreover, their bargaining power vis-à-vis TNCs in order to achieve technology transfers is negligible. As a result, the technological gap between them and the industrialized world is constantly widening.

32 During the Mao era, non-agricultural R&D programmes were mainly geared to military purposes.

33 Even with the cycles and disruptions typical of Chinese history, five-year plans and long-term budget allocations have always supported research and high technology, albeit often inefficiently. By the early 1980s China could count on a large pool of scientists and on a sufficient infrastructural, and institutional base for R&D and S&T endeavours, quite broad even geographically (Suttmeier, 1993).

34 This figure refers to a relatively restrictive definition of S&T and R&D activities (*China Statistical Yearbook*, 2000). The much higher figure for R&D personnel reported in table 10 for the sake of international comparison is from a different source (EIU, 2000) and evidently refers to a less restrictive definition of R&D.

Table 7
Scientific and technical personnel in SOEs and institutions
(Millions of people)

	1980	*1990*	*1995*	*1999*
Total	5.3	10.8	19.1	21.4
Engineering	1.9	5.1	5.6	5.7
Scientific research	0.3	0.3	0.3	0.3
Teaching	1.2	2.1	9.6	11.5

Sources: SSB (2000).

Table 8
Basic statistics on national scientific and technological activities

	1995	*1998*	*1999*
Number of S&T institutions (per 1000)	25	22.1	22.2
Number of personnel engaged in S&T activities (per 10,000)	262.5	281.4	290.6
• Scientists and engineers	155.4	149	159.5
Funding for S&T (billions of yuan)	96	129	146
Expenditure for S&T (billions of yuan)	84.5	112.8	128.5
R&D/GDP (percentage)	0.6	0.7	0.8

Sources: SSB (2000).

The number of published scientific and engineering papers increased strongly over the 1990s. The percentage of these articles which has been catalogued in an international index has more than doubled, and China's ranking in science and engineering publishing activities has improved sharply (table 9). The number of patents and the transaction value in technical markets have increased manyfold (table 11). Partly as a result of these S&T advancements, China's share of high-technology exports in the total of manufactured exports compares rather favourably to those of other developing and developed countries (table 10).

C. Increased awareness of the strategic role of science and technology

By the late 1990s, the impact of the latest wave of technological revolution in the West and its military implications made obvious by the Gulf and the Yugoslavian wars have prompted Chinese leaders to accord an even higher priority to the strengthening of the country's research and innovation capabilities (Suttmeier and Cao, 1999).

Table 9
China: R&D and technology indicators

	1990	*1995*	*1997*
Number of patents applied	41,469	83,045	114,208
Exports of high-technology products (US$ millions)	2,686	10,091	
Scientific papers published:			
• (1) domestically	88,723	107,991	120,851
• (2) catalogued in an international index	13,183	26,395	35,300
• (1) / (2) percentage	15.0	24.0	34.0

	1981–87	*1988–93*	*1995 (rank)*	*1997 (rank)*
China's percentage share of all scientific articles in science and engineering research	0.5	1.1	--	--
China's share of research papers catalogued in the Science Citation Index		1.5	15	12
China's share of research papers catalogued in the Engineering Citation Index		4.8	7	4

Sources: SSB (2000); OECD (1998); Suttmeier and Cao (1999).

Table 10
S&T indicators: China and other countries

	China	*USA*	*Japan*	*Rep. of Korea*	*Germany*	*India*	*Brazil*
Personal computers per 1000 people, 1998	8.9	459	237	157	305	2.7	30
Internet hosts per 10,000 people, January 2000	0.57	1,940	209	60	208	1	26
Scientists & engineers in R&D (in thousands), 1987–1997	454	3,676	4,909	2,193	2,831	149	168
R&D expenditure/GDP, mid-1990s	0.6	2.6	--	2.7	--	--	--
High-technology exports as a percentage of manufactured goods exports, 1998	15	33	26	27	14	5	9
Patents applications – filed by residents (in thousands), 1997	13	126	351	93	62	10	--

Sources: EIU (2000).

Table 11
China: other scientific and technological indicators

		1980	*1990*	*1995*	*1996*	*1997*	*1998*	*1999*
A.	Imports of machines and transport equipment (US$ 100 million)	51.2	168.4	526.4	547.6	527.7	567.7	694.53

		1992	*1995*	*1998*	*1999*
B.	Transaction value in technical market (billions of yuan)	15.08	28.83	43.58	52.34

		1981–85	*1990*	*1995*	*1998*	*1999*
C.	Total patents granted	138	22,588	45,064	67,889	100,156

Sources: SSB (2000); EIU (2000).

A crucial component of China's multifaceted S&T policy is constituted by strategic technology programmes. They have received since 1987 the largest share of direct central government finance for R&D in priority sectors (such as space, laser and supercomputing) through a unique set of procedures and institutional arrangements. They focus on applied research and medium-term results and concentrate the efforts of the country's best technicians and planners. As they represents an explicit link between national security and development issues, technology programmes have been vigorously promoted by elite military-technical cadres, with the aim of widening China's initial narrow focus on weapon building into a comprehensive strategic technology effort.

The pivotal role of strategic S&T programmes is consistent with a long-run trend. Already by the late 1970s, as the new Dengist development strategy was counting on a long period of peace and shifted priorities towards the development of the civilian economy, renewed contacts with the outside world led military and scientific cadres to realize China's retarded economic development, not only with respect to the modest technological level of the country's economy, but also to the management of the entire S&T system. The military themselves realized the "growing interdependence between defence technology and commercial innovation" (Feigenbaum, 1999:100–101). There was an increasing awareness that in the United States and the West improvements in R&D and technology had come about mainly through an increasingly civilian-focused process. However, while opening a number of other channels for less strategic forms of R&D and technological innovations consistent with the market-oriented reforms in the overall Chinese economy, high-level cadres with military experience still accorded priority to state planning and target setting. The key task was not so much the conversion of the S&T apparatus towards civilian use, but the creation of institutions conducive to multiple-use diffusion, according to the multiple-use nature of modern technologies. Primarily non-defence R&D could eventually ease the transfer process and help in building a cooperative managerial infrastructure.

This strategic focus depended to a large extent on the realization that China's severe limits in R&D funding made it necessary to concentrate them effectively on limited areas, and this goal could better be

achieved through planning, i.e. via non-market means. Arguments similar to the familiar Western ones of market failure and economies of scale, strengthened by the high level of uncertainty, the bulky nature of investment in comprehensive top-level research projects and the length of R&D cycles led leaders to reaffirm the necessity for state support for key programmes. This support had to be provided at the central level, as local and provincial governments were being pushed too strongly by the impact of the reforms towards short-term, market-oriented policies, and would not have reaped enough benefits from initiatives of national interest. An ad hoc institutional framework evolved for these large programmes, in which top politicians would cooperate directly with technicians and commit large resources, yet would respect the primacy of technical solutions (Feigenbaum, 1999).[35]

D. The major S&T programmes

The main institution responsible for the elaboration, planning and coordination of strategic R&D and technology programmes is presently the Ministry of Science and Technology (MOST), born of the recent restructuring of the State Science and Technology Commission (SSTC). The SSTC was a central government agency responsible for the nation's science and technology activities (Chang, 1996), with the ultimate aim of fostering economic and social development. Besides promoting research and formulating plans to reform the nation's R&D management system, SSTC (now MOST) has to foster the "commercialization, industrialization and globalization of scientific and technological achievements … to administer the management of the national high technology industry development zones … to formulate policies laws and regulations regarding technology markets, to supervise the implementation of the Law of Technology Contracts … to maintain secrecy and intellectual property rights … to formulate strategies and policies on international science and technology exchange and cooperation … to organize, jointly with other departments concerned, the export of technologies, the introduction of foreign technologies and related assimilation and innovation" (Chang, 1996: 10–11).[36]

MOST promotes and coordinates three major types of actions:[37] basic R&D (centred around the National Programme for Key Basic Research Projects); activities aimed at tackling major S&T problems relevant to economic development, in order to accelerate technological innovation and product regeneration in traditional industries (which includes the Spark programme for the rural economy and a national programme for key S&T projects), as well as initiatives focused on the development of high and emerging technologies and high-technology industries. Some of the main programmes in the latter domain are the national high technology R&D programmes and the Torch programme, initiated in 1988 to promote commercialization and industrialization of key high-technology projects through the market mechanisms. The Torch is a sort of umbrella that directs the development of high and new technology industries, focusing mainly on the electronics sector, in which China has acquired a certain expertise. It promotes product innovations and the creation of high-technology industry development zones, with the aim of

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[35] These developments in the state-run, top-level R&D system were taking place, while in other areas most R&D and innovation activity of less-than-high-technological level was being devolved to decentralized market-oriented non-state agents (see subsection IV.A).

[36] In October,1996 China approved a Law on Accelerating the Commercialization of S&T Research Results.

[37] The MOST also supports the transfer of technology from the defence sector, which has been mandated to assist the development of the civilian economy through various channels, including the restructuring of entire plants.

applying R&D to production and commercialization. Due to the characteristics of the electronics sector, medium-level R&D projects requiring moderate funding might lead relatively quickly to the stages of production and commercialization Consistently, especially in the initial phase, the programme was designed to support essentially SMEs, not big SOEs. Among the various projects carried out in the framework of the Torch programme, those implemented in cooperation with the sprawling new cluster of electronic SMEs in Beijing (which is now spreading to other parts of the country) appear to be particularly promising, as these firms pool a large entrepreneurial and scientific potential. With the support of the Torch programme, some of the former small firms have grown into large industrial groups, as is the case for the well-known Legend Computer Company (Yu, 1999:188).

The National High Technology Research and Development Programme (commonly referred to as 863), launched in March 1986, came to acquire paramount relevance, as it represents an important step forward in strategic S&T planning. The 15-year-old 863 programme is an example of state-centred, yet flexible and articulate approach to the quest for high technology, which is being implemented side by side with other initiatives relying on decentralized entrepreneurship and market signals. It focuses on seven key R&D-intensive fields – automation, biotechnology, energy, information technology, lasers, new materials and space technology – with the aim of promoting their accelerated development and maximizing the results obtained from pooling together all national resources. The 863 programme is national and quite centralized, but it coordinates several institutions at different levels and tries to apply pragmatically both the bottom-up approach to project selection (US style) and the top-down approach (Japanese style). It concentrates on applied science as a means to achieve long-range economic competitiveness, but it also assigns some resources to selected areas of basic research, aiming to achieving a symbiosis between science, engineering and industrialization.

The proponents of 863 argued that high technology had to become the focus of China's long-range development, and the selected sectors were chosen because they were integral to many "system-level" industries, relying on traditional military concepts such as "concentration of forces" and "unified command" to pursue a big push in a non-military direction.[38] In spite of the programme's obvious political relevance, scientists have managed to maintain most of the decision-making process governed by technical criteria. Competition among various R&D institutions for 863 funds also appears to be working. Expert groups make most technical but also financial decisions, through a specific institutional mechanism different from the usual bureaucratic channels, which is proving managerially more effective. These expert groups have thus been allowed by politicians a large share of effective autonomy, "insulation" and real power, in a manner similar to that of planners in the developmental states of East Asia.

The 863 programme is a power structure aimed at cooperation-based avenues to solve critical problems of industrial modernization in a centralized framework, and is having a huge organizational influence on the whole state-directed R&D system. By the mid-1990s the programme's organization, which was initially relatively informal, had been progressively superseded by a more institutionalized and less vertically hierarchical mechanism, based on several national research centres. The institutional structure is such that intra- and inter-level communication is relatively fluid, and the top technical leadership is strongly committed to the programme and (informally) vested with limited proprietary rights. This highly strategic programme has contributed to achieving important scientific and industrial results in

[38] Informal contacts between former military cadres and top politicians, including Deng himself, helped to give 863 priority and funds (Feigenbaum, 1999).

several advanced fields – although its main purpose is still to keep China abreast of top-level international R&D – some of which are now being commercialized (Chang, 1996). Among these results, the single most successful example has been the development of the Shuguang 1000 large-scale parallel computer and the Shuguang Tianchao supercomputer systems, realized jointly by the State Computer Research and Development Centre and by Shuguang Information Industrial Ltd (Yu, 1999: 147).

Even if it represents the most advanced and ambitious component, the 863 programme is only one element of a multifaceted S&T policy which relies on a multiplicity of instruments and also of sectoral development philosophies. China's S&T policy applies a mixed and flexible approach, trying to "walk on two legs". In the fields of top-level technology and world-frontier research it accords priority to centrally coordinated, state-sponsored, targeted R&D programmes. Conversely, in those fields belonging to the lower levels of the technological spectrum, it leaves to decentralized, entrepreneurial, directly market-oriented agents most of the initiatives and the incentives to promote technical progress. Chinese planners "recognize the limits … of targeted industrial policies … the S&T reforms of the 1980s and 1990s (have brought up) significant institutional changes designed to introduce markets, promote entrepreneurialism … and use … government (intervention) to foster an environment conducive to innovation" (Feigenbaum, 1999: 123).

E. The new focus of S&T policies: achievements, limits, and potential

In the 1990s the thrust of China's S&T policies became more bold. It was recognized that the pragmatic drive prevailing in the 1980s had gone too far, and that too low a profile had been kept in such areas as basic research and high technology. In fact, notwithstanding the headway achieved so far, China still has a long way to go on this path. The Chinese economic system is largely non-innovative, and a national technology market is yet in an embryonic, if promising, stage. R&D at the enterprise level is still weak, even in relative terms: in China only about 30 per cent of R&D is carried out by enterprises, compared to 70–80 per cent in the United States (Feigenbaum, 1999; Yu, 1999).[39]

The government has not only emphasized more and more the key role of technology in promoting economic development, but it has also shifted to some extent its goals and priorities in a more ambitious direction. Trying to go beyond the progress already made, it focused on the establishment of the foundations of a national S&T system capable of realizing scientific and technological breakthroughs in frontier, high-technology fields (Yu, 1999). The new strategy is founded on a more mature understanding of the S&T apparatus as a means to improving the overall national system of innovation, taking fully into account the position of China vis-à-vis the outside world. Increased emphasis is being put on the professionalization of research activities, on the enhancement of the economic and social role of innovators, and on the effort to harness the vast scientific potential represented by the large community of Chinese researchers working overseas. Resources are to be concentrated on a limited set of targets under the highest policy direction, and horizontal international research cooperation with public and private foreign partners is being actively promoted (Suttmeier and Cao, 1999).

A major step in shaping the new S&T strategy was the 1995 National Science Conference, which ended with the approval of the Decision to Accelerate the Development of Science and Technology. The

[39] Recent industrial reforms aiming at consolidating large SOEs and strengthening their R&D activities appear to be heading in the right direction.

Decision, besides stressing the highest political priority accorded to scientific development, set a significant quantitative target: gross expenditure on R&D was set to reach 1.5 per cent of GDP by the year 2000. This policy line was confirmed at the Fifteenth Party Congress in 1997 and at the National People's Congress meetings in 1999, as well as in the statements of top government leaders. Consequently, the amount of resources devoted to S&T has continued to grow. However, in relative terms, the goal of substantially increasing the R&D/GDP ratios and the proportion of R&D activities carried out directly by productive enterprises has not yet been met.

The data discussed in subsection IV.B suggest that China's progress has been quite remarkable, with respect both to the country's recent past and to its positioning on the world technological ladder and in the international division of labour. China is no longer just a producer of labour-intensive, low-tech manufactures. Owing largely to the size effect, by the end of the millennium China's overall international ranking in terms of R&D outputs was roughly in line with its ranking as an exporter (i.e. among the world's 10–15 top nations), notwithstanding its much less satisfactory relative position in terms of the development of the educational system. While in less than a decade China's high-technology exports, patents and internationally recognized scientific papers have multiplied by two or threefold, university enrolment has increased only by 50 per cent and the number of R&D personnel has risen quite marginally. These non-homogeneous trends show that important results have been achieved so far mainly by means of an improvement in the efficiency of the country's S&T system, as the R&D and educational inputs have been growing roughly at the (indeed fast) pace of the country's overall economy. A true knowledge-based revolution in terms of mass access to higher education and of a substantial increase in the economy's R&D intensity – as has already occurred in the West and in a handful of Asian NICs – has yet to take place in China. If such a phenomenon happens, in another generation China will be one of the first two or three world scientific and technological powers.

V. ENTERPRISES AS KEY PLAYERS IN THE TECHNICAL PROGRESS-GENERATING PROCESS: SOEs AND COEs UP TO THE LATE 1990s

A. Enterprise autonomy in the state and collective industrial sectors

In the preceding section the importance of state-planned R&D and especially of strategic technology programmes has been emphasized. However, in a reforming socialist economy like China, as in any other complex modern economy, the focal locus of technical progress generation is the enterprise, the organization in which in-firm or externally generated new knowledge is applied to market-oriented and/or market-compatible production and eventually commercialized. In the theoretical framework of the evolutionary approach, productive enterprises should be considered an integral part of the broadly defined NSI, as one of the mutually interacting subsystems in which learning and innovation take place (Lundvall, 1992).

In China, SOEs, and to a lesser extent COEs, must consult with several other local and sometimes central agencies, to have their decisions administratively ratified. Although higher planning or sectoral specialized agencies do exist and often interact with them, and extensive consultations with other bodies and institutions are common, enterprises are increasingly in charge of final and important decisions in the domains of technology acquisition and implementation of productive innovations, utilizing their comparative

informational advantages as final users of potentially valuable new knowledge (Grow, 1993). Taking into account the substantive autonomy enjoyed by both COEs and SOEs, many firm-specific factors favouring the effective acquisition of foreign technology – such as managerial capability, entrepreneurship, internal communication and participation and flexibility – are common to all manager-run enterprises operating in a regime of separation between ownership and control, quite independently of the ultimately public or private nature of their principals.[40]

As a result of the increasing impact of industrial reforms, managers of medium and large enterprises in both subsectors of China's socialist industry[41] enjoy a high level of autonomy, not very different from that of their counterparts in the corporate private sector of the advanced capitalist countries. They concentrate in their hands most of the decisional power and responsibilities related to the incentives and risks of actual changes in the production and distribution processes. While scientists in the R&D laboratory can to some extent be isolated in an ivory tower, and functionaries managing state-sponsored S&T programmes deal only indirectly with firms, managers responsible for the implementation of innovations live directly the social and economic consequences of their actions (or inaction).[42]

As far as they act as agents of principals exclusively or fundamentally interested in economic and financial goals, managers of publicly owned enterprises tend to behave like capitalist managers vis-à-vis the risks and opportunities related to technology choices. When, on the other hand, principals over-impose on managers a different kind of agenda, motivated by strategic, social or political issues, the managers' behaviour necessarily changes. By the late 1990s this situation, though far from uncommon, was tending to become the exception rather than the rule.[43]

By and large, Chinese industrial managers appear to be sufficiently motivated to acquire new technology, promote in-firm R&D, improve their staff's technical skills, and apply to production both product and process innovations, as they see it as a way to thrive and realize profits in an increasingly competitive market. The managers' incentives structure is still being improved, and some important changes are going to be implemented in the framework of the corporatization of a large part of the present SOE sector.

At the level of the enterprise, therefore, reforms have already gone a long way to increase the propensity of managers to foster technical progress, improving significantly on the previous passive stance

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[40] Research carried out in advanced capitalist countries on concrete case stories, such as Toyota in Japan or large corporations in the United States, shows that national government commitments to technical progress and overall policy efforts aimed at S&T development are far from irrelevant, but the "masters of change" tend to be chiefly those in the "functional economic organizations – the industrial enterprise – that actually implement the new process or product technologies" (Grow, 1993: 818; Kanter, 1983: 432; Brenner, 1987: xi–244).

[41] Of course, as a general rule, COEs continue to have a higher degree of autonomy than SOEs. However, especially if only large and medium-scale enterprises are taken into account, the relatively large size of COEs means that local governments acting as owners cannot ignore completely their impact on employment and ultimately on the social fabric of the area in which they operate. Hence, managers of medium and large COEs are likely to face, even if to a lesser extent, some kind of not purely economic demands from their principals, just like SOE managers.

[42] Implementing a major innovation, for instance, might have a non-negligible impact on labour organization and intensity, the skills required from staff and its internal hierarchy, and the employment level. Conversely, non-implementation might jeopardize the very viability of the enterprise and lead to dramatic job losses.

[43] For instance, Shinua coal company appears to have been strategically weakened by a forced merger with several smaller and inefficient mining enterprises (Nolan, 1999a).

of socialist managers in pre-reform times.[44] Most of the residual agenda of industrial reforms is focussed on the "meso" level of industrial organization, which is to be shaped consistently with the main objectives of strategic industrial and technological policies, in order to exploit fully the potential benefits stemming from market-compatible planning and judicious centralized intervention. Enterprise autonomy, however, can be limited or enhanced by the relation between managers, as agents, and their often multiple principals and partners. Among public and quasi-public industrial enterprises, differences in size and in the level of socialization of property rights are reflected in significant operational and behavioural differences. These differences, however, do not prove the universal superiority of one specific type of public firm, and even less the need for a generalized privatization of industrial enterprises. Rather, COEs and reforming SOEs should be considered as distinct instruments to target different sections of the overall technological spectrum, with the aim of maximizing the long-term rate of technical progress in the economy as a whole.

B. The success of the collective sector: ambiguous property rights and spillovers from SOEs

The results of industrial reforms so far appear to show a mixed picture. On the one hand, the SOE sector output grew rather fast in quantitative terms, even if less rapidly than in the other industrial sectors. On the other hand, the sector experienced a severe financial deterioration.[45] Conversely, there is no disputing the fact that not only production but also efficiency and productivity rose very fast in the collective and private sectors of industry, as well as in agriculture, following the inception of reforms in the late 1970s (see section VI). It would be incorrect to attribute these gains to a de facto quasi-privatization process, which would have taken place in the collective industrial sector as it did before in the domain of agriculture. Property rights in COEs are rather ambiguous, but remain substantially public, like those of SOEs.

Ambiguous property rights arise as an adaptation to an imperfect market environment and in response to high transaction costs and uncertainties in the market place. Non-state firms, even if they are founded by entrepreneurs, find it advantageous to team up with local governments because of the existence of a "gray" market, which can be heavily altered by government intervention or inaction. Ambiguity in tax rates and the ubiquity of negotiations also favour the joint running of the firm (Li, 1996).[46] The persistence of a cooperative culture and of a common moral solidarity framework in rural Chinese communities contributes to minimizing the dangers of this type of property rights arrangement (Byrd and Lin, 1990; Jefferson, Mai and Zhao, 1999).

However, the relationship between local leaders (as principals) and managers (as agents) in running COEs is undergoing continuous evolution (Chen and Rozelle, 1999). With the development of market

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[44] Gradual market-oriented changes appear to follow a largely endogenous path, in which various institutional agents enjoying positive feedbacks progressively contribute to the establishment of de facto constituencies favourable to the prosecution of the reform process (Jefferson, Ping and Zhao, 1999).

[45] In the period between the late 1980s and the early 1990s fiscal and financial subsidies to SOEs had also to be increased as a compensatory measure. The worsening of SOE sector's overall financial situation continued up to the late 1990s.

[46] The author recognizes that his theory explains the relative efficiency of ambiguous property rights, not the great success of COEs. So he conjectures: "Can the unconventional arrangements of ambiguous ownership be justified in a larger context than market imperfections?" (Li, 1996: 16). Our view is that ambiguous property rights contribute to overcome to some extent the trade-off between efficiency and public ownership of the means of production, and that the latter has intrinsic advantages for capital accumulation (see subsection V.E).

transactions and the proliferation of COEs, on the one hand, it has become increasingly cumbersome for leaders to run firms without the help of specialized managers. On the other hand, their specific managerial functions have become less needed, as managers can get inputs and other factors of production through market channels. Thus, a tendency has arisen to delegate managerial functions to specialized agents, and contracts have evolved favouring profit-sharing or leasing (fixed-payment) arrangements. The institutional changes in the COE sector show that market development is leading to contractual arrangements which resemble more closely those of private enterprises, albeit in a socialist property rights regime. If coupled with increasingly tight budget constraints,[47] these changes increase the incentives for innovation among agents in the collective sector. Changes in contractual arrangements for COEs are in fact a form of institutional innovation which contributes to overall technical progress.

However, capital- and knowledge-intensive COEs tend to remain more directly controlled by leaders, as they embody a higher share of social capital, which has often been obtained through non-market channels from more technologically advanced enterprises, mostly SOEs.[48] Actually, COEs often profit from an array of physical and human capital transfers from SOEs, arranged through ad hoc transactions which create a kind of informal technology market at the local level (Fan, 1999). As such, markets would not exists under pure *laissez-faire* conditions, the existence of SOEs allows collective enterprises to benefit from significant technological spillovers.[49] These spillovers contribute to explaining the superior efficiency of COEs in low- and medium-technology industries, in which small-scale firms enjoy an organizational comparative advantage (Murakami et al., 1994, 1996).[50]

C. The two stages of SOE reform

The reform process in the state-owned industrial sector was initiated in the late 1970s. At first, it focused mainly on the contract instrument, modelled after the household responsibility system (HRS), which was considered by many observers as the key to the success of the agrarian reform.[51]

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[47] The budget constraint is quite binding for COEs, but also in the collective sector it is not always entirely hard. COEs often stay in business for a long time even if they are in the red, as was shown for instance by Wang (1990) in a study on 100 rural firms. However, the potential for earmarking large subsidies to inefficient firms for very long periods, leading to major losses, is limited by the relatively modest size of local government finances. This phenomenon can also be interpreted in the framework of the ambiguous property rights approach.

[48] As in the state-owned sector, these firms tend to be more directly monitored by principals with respect to ordinary COEs, showing that their optimum governance requires a higher level of socialization of management, besides purely ownership functions, and a higher degree of non-market coordination.

[49] COEs often obtain cheap machinery and equipment discarded from state enterprises, and many SOE engineers and technicians act as consultants for TVEs in order to obtain extra income. According to surveys, over 90 per cent of COEs cite SOEs as their main source of new technology (Jefferson et al., 1992).

[50] Consistently with this finding, statistical data show that most small SOEs perform poorly, while large and medium-scale SOEs tend to be successful (see subsection V.D).

[51] According to a recent econometric study, in the first period of agricultural reforms technical change accounted for 40 per cent of increase in yield of rice, more than institutional change. Afterwards, technical progress contributed to virtually all yield growth. Thus, improvements in incentive coming from the introduction of the HRS appear to have been a one-off event (Huang and Rozelle, 1996). This finding shows that it would be wrong to overemphasize the benefits of decollectivization, decentralization, and commercialization, while overlooking the problems created by their having gone too far. These reforms also had a negative impact, as they led to forgoing several advantages of the previous collectivized system in terms of planning, distribution and execution of several collective tasks (a typical example is the deterioration of water management, which is crucial in particular for rice production). With respect to the goal of accelerating technical progress, the reforms are likely to have improved farmers' incentive to adopt more profitable technologies. However, the supply of new technology via basic research, which was rather satisfactory in the pre-reform period, has somewhat deteriorated, owing to the partial breakdown

Reformers were thus targeting one major constraint to improved SOE performance, the managers' (and, to a lesser extent, workers') incentive structure, so as to enhance their autonomous power to take strategic decisions. Decentralization of decision-making power to increasingly market-oriented productive units was consistent with the gradual but thorough shift from plan to market coordination of production and distribution relations which was taking place in the Chinese economy. While improving the agents' (managers') behavioural functions, however, the initial reforms failed to address the issue of modernizing and diversifying the principals' ownership structure in order to improve overall corporate governance, a task which would have been at the centre of the second stage of industrial reforms since the mid-1990s.

The Enterprise Contract Responsibility System (CRS), which specified reciprocal rights and obligations, pledges and targets, took several forms. A typical one was the "two guarantees and one linkage" contract, in which the firm pledged to realize a certain level of tax and profits, and also to finance the technical renovation required by the state with its own funds. These contracts became the norm by the late 1980s. Moreover, SOEs could sell more and more output at market prices,[52] and could retain profits for investment, welfare programmes and bonuses. These reforms strengthened the profit motive and also the "impetus for technical progress and product innovation" (Lin et al.: 64). The contract responsibility system strengthened the linkage between the firm's performance and the prosperity of the local government and/or other principals, and thus improved the incentives system. It achieved a reduction in the softness of the budget constraint and helped to turn large SOEs towards profit. Conversely, poor-performing SOEs were put under increasing pressure, as were their workers too. Some SOEs started to try to get rid of the unprofitable parts of their businesses, and many fast-growing and fast-modernizing large and medium-scale enterprises (LMEs) emerged under this system.

As a result of the partial reforms implemented during the first decade, it appears that the "internal" incentive structure faced by SOE managers (and to some extent workers as well) in the late 1980s to early 1990s was approaching that of COEs and of private enterprises, owing to the effectively enhanced autonomy of enterprises and to the paramount priority assigned to the profit objective.

However, SOEs, which remained at the core of the advanced R&D and innovation effort of the country's industry and were endowed with the bulk of the most advanced physical and human capital, were still burdened by another set of "external" constraints. The most serious of these constraints was constituted by excessively high direct and indirect labour costs, stemming from the historical urban bias of the state, the fragmentation of the labour market, the political strength of concentrated urban workers, and the lack of alternative state-funded universal welfare systems. Moreover, non-strategic bureaucratic interference, albeit less widespread, continued to be a problem.

The limited results obtained by the reforms prompted a lively discussion, which led to the adoption of a partially new strategy emphasizing efficiency improvements in large SOEs and a gradual destatization[53] of non-strategic large SOEs and of most medium and small ones. Moreover, the remaining

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of collective institutions, excessive decentralization, and in the pursuit of short-term marketable results. The state-run rice research system, which had been very successful during the in Mao era (new rice varieties were introduced in China in the 1960s, before the Green Revolution), thanks in part to its almost self-sufficient character, has been particularly affected.

[52] The dual-track system withered progressively in favour of market allocation, although a few key prices are still plan-determined.

[53] Destatization is not synonymous with privatization, although the latter can be one of the tools of the former.

state enterprises were to concentrate on economic goals, while their traditional social functions would be progressively shifted to external welfare systems.[54]

The "grasping the big and enlivening the small" strategy was launched originally in 1994. The Thousand-Firm Reinvigoration Programme, which envisaged the maintenance of an enhanced SOE status for about 1000 large SOEs, along with a number of measures aimed at ensuring their autonomy and promoting technical upgrading and the full exploitation of economies of scale, constitutes the core of the ongoing reform initiatives implemented since the second part of the decade (Jefferson, Mai and Zhao, 1999).[55] The CRS system was formally ended in 1994, with a view to replacing it with the new system of joint-stock companies. In practice, as usual, their lot was one of continuity, with important negotiations still going on between principals and agents[56] However, the process of ownership diversification in large SOEs, did proceed albeit gradually. By the late 1990s, it was in full steam, and was beginning to allow transcending the limits of the previous forms of ownership and operation, as boards of directors and shareholders acted as a cushion again excessive ad hoc bureaucratic intervention.

Under the new system enterprise owners are a multiplicity of institutions, which usually include the local government, the relevant ministry or quasi-ministerial body, other domestic institutional shareholders, and often a foreign joint venture partner and thus foreign shareholders. Different players have partially different agendas, but their interaction can contribute to the firm's performance in a more flexible way than in the past (Broadman, 1999).[57] Policy initiatives targeted at the other side of the SOE spectrum, aimed at terminating state tutelage on non-strategic SOEs, include the establishment of 150 property rights transaction centres. In these centres different types of enterprises can trade reciprocally in their firm-specific assets, with the goal of reaching an improved match of human and physical resources in a market-driven fashion (Jefferson, Mai and Zhao, 1999).

The cumulative impact of various policy initiatives – which to a large extent are not the result of a top-down planning approach but arise endogenously as a byproduct of the growth and development needs of the enterprises system – is beginning to constitute a relevant qualitative change in the very nature of public ownership, with several public owners interacting and negotiating reciprocally in a contestable property-rights market. In this market public agents must take into account the opportunity cost of managing directly their industrial assets vis-à-vis the alternative option of negotiating with other enterprises, institutions or individual entrepreneurs which may be able to use them more productively. As a result, relatively spontaneous market mechanisms can help improve incentives and resource allocation, without necessitating withdrawal from the ultimately public nature of the ownership of most industrial assets (Jefferson, 1998).[58]

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[54] According to Eyraud (1999), SOEs are no longer "total social institutions" and are progressively becoming purely economic entities.

[55] The state intends to maintain a controlling share ownership in the pillar industries and in key enterprises in the basic industries, as well as in many strategic enterprises in high-technology sectors.

[56] In some very heavy industries, like steel, contracting survived also *de jure*.

[57] Huang et al. (1999a) acknowledge an improvement in the new reform strategy, recognizing that it provides local government with the incentive and autonomy for adopting different approaches.

[58] According to Jefferson (1998), the emergence of a property-rights market in which public agents voluntarily engage in efficiency-enhancing transactions is consistent with the theoretical approach pioneered by Coase (1960).

Actual implementation of the reform strategy was at best partial up to the late 1990s, but it appears to have accelerated since 1998–1999, taking into account practical policy actions implemented and the emphasis accorded to the issue in the official political discourse (OECD, 2000). The process of dissolving inefficient SOEs through mergers and bankruptcies, sharing costs among central and local government and banks, has been initially very slow and contradictory. Since 1996, the central government has been channelling into the restructuring process huge sums of money,[59] with less than fully satisfactory results. Some firms have been declared bankrupt and then reopened under a new name, shifting losses onto state banks (Gao and Yao, 1999). Money-losing enterprises are sectorally and geographically concentrated in mature heavy industries and also in textiles, many of which are in north-west China. Practical and technical difficulties in the actual application of the bankruptcy law have in recent years prompted a shift of emphasis towards the corporatization of SOE debt, consistently with the ongoing reform focus on SOE corporatization and ownership diversification. Domestic institutions participating in the process include stock companies, non-bank financial institutions and SOEs with at least one non-state owner. State shares belong to the central government, the local government, and other SOEs, although legally their ultimate owner is the State Council. Besides domestic institutional investors, share quotas in listed companies can also be owned by foreign investors, employees and other individuals.

Principal-agent problems do arise with representatives of the state ministries, but tend to be less intense with agents operating in financial institutions, while small shareholders are dispersed and exercise little control power.[60] Legal person shareholders in China are not only better motivated but also better equipped, as they are elected on the board of directors and hence have greater access to information. They can effectively ensure "that managers work in the interest of shareholders through direct control. Sitting on the board … they are able to change the management team … [they] have played a positive role in monitoring the management and improving the firm's performance" (Xu and Wang, 1999: 91–92). A diversified ownership structure appears to constitute an advancement with respect to traditional vertical and bureaucratic state ownership. However, excessive dispersion of ownership is to be avoided. In China, as in the West, there appears to be a positive and significant correlation between ownership concentration and profitability (Xu and Wang, 1999), as only large shareholders have sufficient incentive and ability to effectively exercise monitoring rights, as they can reap benefits.[61]

Hence, it appears that corporate governance in the reforming SOE sector can best be assured through an optimum level of intermediation, in which "legal persons" – specialized public financial and governance institutions isolated from day-to-day political processes – play a pivotal role.[62]

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[59] Funds earmarked for SOE restructuring are estimated at about 30 billion yuan each year in 1996 and 1997, and 40 billion yuan in 1998 (Gao and Yao, 1999).

[60] The weak control power of smallholders may be beneficial to the firm, as smallholders tend to act opportunistically and in a short-term speculative manner.

[61] Studies conducted in the United States and other OECD economies show s a positive correlation between shareholding of large investors and firm performance, as a result of institutional investors' superior monitoring ability with respect to atomized individual shareholders.

[62] The superiority of "legal persons" as corporate governance agents is related to their relatively higher degree of autonomy, insulation and market-orientation with respect to traditional bureaucratic and ministerial bodies. According to Xu and Wang (1999: 94) industrial reforms in China "seem to have improved the economic efficiency of the state sector", but still "the internal incentive structure of SOEs must be reformed by diversifying the state ownership and by introducing other forms of large shareholders, including institution investors". However, under special but sometimes crucial circumstances, where long-term strategic planning in ambitious high-technology ventures can be the only hope for technological leapfrogging, a higher degree of centralization and of non-market coordination may be necessary.

D. The key role of large SOEs

Since the early 1990s the share of total industrial output produced by SOEs fell below 50 per cent and is now less than one third of the total. However, if firm size is considered, LMEs – most of them SOEs – outperformed small-scale enterprises. In 1980–1993, LME share in total industrial output increased from 42 to 46 per cent. If the formal sector of the industry alone is considered (all townships and above, as well as independently accounting industrial enterprises), the increase is higher, from 43 to 56 per cent[63] (Lo, 1999). Clearly, small SOEs accounted for most if not all of the relative decline of the whole state sector;[64] conversely, the performance of medium and large SOEs has been on average as good as that of COEs.

Even before the beginning of the new phase of the new reform round in the second half of the 1990s, state-owned LMEs were able to achieve good results in terms of production and sales, not only owing to their superior command of physical, human and financial capital, but also as a result of their extensive engagement in innovative activities. A national survey conducted in 1992 showed that over 90 per cent of LMEs were carrying out some form of product or process innovation, and more than 50 per cent were implementing major innovations (Ma and Zhao, 1993). A more selective and thorough survey carried out in the early 1990s confirmed that reforms had achieved the goal of creating new links between profits and employee compensation and that all types of enterprises (SOEs as well as urban and rural COEs) enjoyed a higher degree of autonomy. The survey also showed that the more technically advanced SOEs concentrated most resources on innovation, as well as technicians and R&D expenditures, while smaller COEs tended to be more financially constrained in their innovative activities. In relative terms, COEs earmarked to innovation a larger share of their output than did state enterprises, but the bulk of innovation expenditure was concentrated among the largest SOEs. The latter engaged in frontier R&D and innovation activities, while COEs acted rather as technological followers, with their innovative efforts consisting mainly of imitating and catching up with SOE superior technology. Large SOE innovations were less numerous but more important than COE innovations, and their contribution to total profit was greater (Jefferson et al., 1997).[65]

These trends suggest that the performance of the subsector of big, large-scale SOEs has been quite satisfactory, as opposed to that of small SOEs, and provides support to the policy of "grasping the big, enlivening the small", which is presently being implemented. state-owned LMEs are "at the heart of China's transformed Soviet-type economy" (Lo, 99: 694).[66] A proper combination of planning and market

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[63] These figures also indicate that industrial output not only increased very fast in informal, mostly individually owned firms (see section VI), but also in village-level COEs. Most of these micro-enterprises are located in rural areas.

[64] Small COEs fared no worse than the larger COEs.

[65] The results of this survey depict the situation prevailing in the late 1980s and early 1990s. The subsequent acceleration of the reforms and of the country's opening up has multiplicated the chances for many enterprises of any type to gain access to advanced technology, and as a result there are now several COEs which have grown larger and technologically sophisticated. However, the bulk of frontier innovation activity is still carried out in the large SOE sector.

[66] A recent OECD study acknowledges "several important strengths" in China's economic reform process. It also notes that the reforms have been particularly deep and bold in larger SOEs, while problems of other enterprise sectors have received less attention (OECD, 2000: 103–104).

coordination based on an upgraded form of state ownership[67] – *a fortiori* in a large developing country such as China – can offer important advantages in concentrating the effort for technological modernization in the most advanced, capital- and knowledge-intensive industrial sectors. The overall tendency is not leaning towards privatization but in the direction of pluralized institutional ownership (Nolan and Wang, 1999), with managerial autonomy counterbalanced to some extent by the strong interest of local and also national officials in the firms' performance. As national governance institutions are in the best position to bargain with TNCs for technical transfers, this institutionally new form of state intervention presents important strategic advantages.[68] Furthermore, large SOEs can be a key component of a balanced development path, with light and heavy industries growing aside (Nolan, 1996). In this context, large SOEs, even if in a diversified ownership institutional framework, achieve economies of scale and scope, acting as long-term oriented market-supplanting institutions, while more directly market-oriented small and medium COEs benefit indirectly from their symbiosis with SOEs.

The good performance of the LME subsector of SOEs provides support to the institutionalist perspective of the late industrialization literature. Imperfect markets can usefully be matched by imperfect property rights, and consequently by a set of specific institutions and organizations. Large SOEs have been able to prosper in a framework consisting of the "collective learning paradigm" literature, which argues that in the context of late industrialization entrepreneurship is largely a collective phenomenon,[69] with internal agents (managers, workers) and major external partners (including to a certain extent political bodies which also act as stakeholders) interacting virtuously through relations which are not exclusively market-based (Amsden, 1989; Aoki, 1990; Naughton, 1994; Nolan, 1999b).

Another interesting phenomenon is constituted by the progressive emergence of large *chaebol*-like SOE groups. Among the most successful examples are those of Sanjiu and Shougang. The Sanjiu pharmaceutical group grew out of a firm belonging to the army, which developed strategically an initial comparative advantage in the field of traditional Chinese medicine. Shougang, the second largest steel producer in China, has been particularly successful in pursuing long-term strategic goals instead of short-term profits. Thriving state-owned industrial groups are found in other heavy sectors such as petrochemicals, and motor vehicles, and also in light industries such as beverages and household electric appliances (Nolan, 1996).[70]

The formation of these conglomerates, which typically have at their core a large SOE with an interest in upgrading technologically its junior partners and controlling the quality of their supplies, often involves a process of mergers and acquisitions (M&A). M&A can be of a "defensive" nature, with the state mandating a large SOE to absorb and reorganize a smaller ailing one. Not surprisingly, this top-down process is not always efficient (Nolan, 1999a). Conversely, other M&A are bottom-up processes emerging from the initiative of a successful and dynamic large SOE, resulting in practice in takeovers. Due

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[67] The process of industrial enterprise corporatization is most advanced among large SOEs, and a complex web of public ownership is being created, with corporate governance jointly carried out by more and more layers of reformed and new quasi-state institutions.

[68] In promoting institutional and organizational modernization of large SOEs, China is to some extent following and developing on the previous experiences of other East Asian "developmental" or "entrepreneurial" economies.

[69] Well-known examples of very successful SOEs in other newly industrialized Asian countries are those of Posco (in the Republic of Korea) and China Steel (in Taiwan Province of China) (Nolan, 1999b).

[70] China has established a footing also in the very advanced and monopolistic aerospace and aircraft industries, although it is far from being able to manufacture aeroplanes on a self-sufficiently basis (Nolan, 1999c).

to the paucity of managerial skills in China, and the scarce development of market institutions, mergers can be very effective in advancing overall business capabilities and generating positive externalities.[71]

E. Accumulation and technical progress in a socialist market economy

The evolving structure of industrial enterprises appears to be consistent with other systemic features of the accumulation and investment process, which might be responsible in part for the fast development of China's socialist market economy.

The ambiguous property rights prevailing in COEs constitute a relatively efficient arrangement, which is compatible with a strongly market-oriented growth path. SOEs are undergoing a gradual reform process aimed at concentrating resources on a few large and strategic firms, which are expected to operate in high-technology sectors within a diversified property rights framework. Yet, in both industrial subsectors the fact that ultimate property rights are socialized at the level of one or more institutional principals (national government, local government, banks, financial and management agencies)[72] can be beneficial to investment and accumulation, in comparison with the typical situation existing in other developing countries. In the latter, the national agent of accumulation[73] is the local bourgeoisie, which either controls most of the capital directly or commands it through the local bank structure, while in China such a collective agent is constituted by a complex web of public bodies. Leakages from potentially available investment funds owing to the conspicuous consumption of the bourgeoisie,[74] and to related financial phenomena such as capital flight, constitute a brake on the development of national productive forces.

Conversely, in a socialist economy, public economic and financial agents can in principle pool a large amount of both forced and voluntary savings, and utilize productively the previously accumulated industrial capital stemming from past undistributed profits. However, traditional socialist economies have coupled a high accumulation potential with a low degree of market orientation and a poor incentive structure, leading to a high level of inefficiency. The complex challenge in China, as in other reforming socialist countries, is to retain the positive features of the traditional socialist model, mainly in the fields of capital accumulation and income distribution,[75] while simultaneously achieving a satisfactory level of

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[71] According to Nolan and Wang (1999), the "big" industrial groups which are emerging in China are still too "small" to compete with real TNC giants (only in employment are they comparable in size). Mergers of two or more large SOEs could create industrial giants of sufficient strength to really compete globally, and the state should actively contribute to this concentration process, as it has elsewhere in Asia.

[72] The government maintains that "public ownership" remains "a dominant feature of the economy" (Tam, 1999: 15). It is becoming increasingly common that foreign (more rarely, national) private investors also share property rights in corporatized ex-SOEs. Apart from the cases of true joint ventures, however, ultimate control still resides with public institutions.

[73] In a few developing countries, though to a lesser extent than in China, TNC also contribute to investment through FDI. The limits of FDI potential for development were briefly discussed in section II.

[74] In many developing countries other privileged classes, such as rural landlords, also contribute to the same phenomenon.

[75] The realization of the potential distributional advantages of the public ownership of the main means of production is not automatic (see footnote 12). In China, in particular, there are major spatial income inequalities, stemming from the urban/rural divide and the uneven development of different regions. Following the exhaustion of the initial positive impact of agricultural reforms on income distribution, stemming from the rapid increase in long depressed rural incomes, the explosive development of coastal regions has deepened geographical inequalities during the last 15 years, although all provinces have experienced some growth (Hu and Wang, 1999).

efficiency in the allocation of resources and developing an adequate system of innovation conducive to a speedy rate of technical progress.[76]

It should also be taken into account that, contrary to the textbook abstraction according to which technology would be exogenous and disembodied, and hence theoretically separable and independent from real life investment processes, "most technological progress (if not all) must be embodied in new inputs" (Felipe, 1999: 22).[77] Therefore, unless it takes place in a particularly inefficient and market incompatible framework, a sustained accumulation process is per se an important factor conducive to fast technical progress, especially in a catching-up economy with a high potential for technology absorption from abroad. The industrial reform process in China has so far been compatible with the maintenance of a high rate of accumulation, in spite of the negative impact of increased competition on profit rates, while at the same time fostering the development of a complex innovation ladder enhancing imitative technological spillovers flowing from the more advanced core to the millions of peripheral enterprises (Jefferson and Rawski, 1999).[78]

In rural areas in particular, decentralized, strongly market-oriented COEs have tapped their structural potential advantages, including those stemming from their relatively underdeveloped technology. In these enterprises ambiguous property rights ensure that this locally relevant high pool of investable resources is utilized in a largely profit-maximizing way. Market orientation is assured by the relative hardness of budget constraints, as local governments are too small to save ailing firms, nor are they under a formal or even political obligation to do so.[79] In the state-owned industrial sector, which has traditionally benefited from the enormous potential of socialist centralized planning apparatuses for the extraction and pooling of resources, the trade-off between accumulation and efficiency has been progressively deteriorating following the initial stage of industrialization, leading to successive waves of reforms. The reforms have led, on balance, to significant improvements in terms of productive performance and innovative propensity, but also to a deepening bifurcation inside state-owned industry, with LMEs performing well, while many other SOEs have improved little in terms of efficiency and have caused increasing financial losses.

In low and medium-technology sectors, COEs tend to improve TFP faster than most SOEs. Shifting progressively to the non-state sector the bulk of presently existing SOEs can lead to an increase

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[76] The ability to absorb productively a sustained rate of capital accumulation was a crucial component of the "miraculous" growth phenomenon in many Asian economies (Nelson and Pack, 1999).

[77] "… the act of purchasing a new piece of machinery (that is, investment) represents technical progress in itself in that it entails a different method of production. It is not clear that purchasing the machinery represents exclusively capital accumulation" (ibid.: 22). Felipe refers to the classical contributions by Kaldor (1957), Solow (1960) and Arrow (1962), and argues that the embodied character of technical progress does not allow to identify it simply with Solow's residual, as it is often implicitly assumed in many TFP-accounting exercises (see footnote 84).

[78] During the reform period, high rates of accumulation and of technical progress de facto proved compatible with the maintenance of a high, albeit diminishing, degree of what orthodox economists describe as static allocative inefficiency. As an hypothesis to be tested by further research, it might be argued that the Chinese economy displays an implicit systemic consistency, according to which static allocative inefficiency was at least in part a condition for technical progress itself. If this hypothesis were true, any approach to future reforms which placed overdue emphasis on piecemeal attempts at improving static allocative efficiency should be regarded with caution.

[79] However, because of their residual public character, many COEs survive in the red for longer than would normally be the case for private firms (see footnote 47).

in efficiency and growth potential[80] for the entire economy,[81] although at the price of a drop in the welfare of many previously relatively privileged workers. However, the positive record of LMEs provides support to another major component of the Chinese industrial strategy which aims at concentrating the most advanced S&T potential on a small number of elite SOEs, along with sufficient human capital and financial resources, in order to spearhead technical progress in the most advanced fields and to maximize its economy-wide spillovers. If properly implemented, this two-pronged strategy might allow to retain the advantages of socialized ownership while overcoming the traditional dynamic inefficiencies of Soviet-type industry.

VI. DID REFORMS FOSTER TECHNICAL PROGRESS?

A. The controversy on the effectiveness of industrial reforms in SOEs

Many analysts tend to dismiss the depth and effectiveness of the successive waves of reforms in the core of the state-held industrial sector. SOEs are seen as money losers, acting as a drain on the rest of the economy through the fiscal and financial subsidies they require from the state, captured by bureaucrats' and insiders' vested interests, prone to wasteful overinvestment and to excessively generous wages and welfare expenditure, and hopelessly slow in catching up with technical progress. Lin et al. (1999) recognize that the reforms enhanced the profit motive and thus the incentives for technical progress and product innovation, but argue that SOEs are still too numerous to be properly monitored by the state and too burdened by welfare costs and inefficiencies, and that they therefore represent a source of huge financial losses. Huang et al. (1999b) dismiss the argument according to which SOE profitability was affected by increased competition, on the ground that the profitability of state-owned firms declined also in non-competitive, heavy sectors, while in almost every sector non-state enterprises did obtain positive financial results. Huang et al. (1999a) agree on the fact that reforms did enhance enterprise autonomy, but contend that the payoff has been scarce, as political, ideological and social constraints de facto minimized the effective threat which was supposed to arise from the growing budget constraints and risk of bankruptcy. As a result, SOEs were captured by insiders (managers and workers), who disregarded the principal's (state) interests (Sicular, 1995;[82] Nichols and Zhao, 1996[83]). Huang et al. (1999a: 1) state bluntly that "SOE reform in China has been a failure", and that the only long-term solution lies in the outright privatization of state-owned industry.

In fact, the limited evidence stemming from statistical studies appears to show that there was a certain qualitative improvement in the performance of SOEs in the early stages of industrial reforms,

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[80] The advisability of narrowing the definition of the strategic core of SOEs is partly consistent, for instance, with some of the policy conclusions of OECD (2000: 105).

[81] To the extent that TVEs benefit from technological spillovers from SOEs, the existence of state industry leads to less overall efficiency loss than commonly thought, because part of the fast growth of TVEs is made possible by its symbiosis with SOEs.

[82] Referred to in Huang et al. (1999a).

[83] This view is strengthened by the observation that real wages in SOEs increased by 50 per cent in 1985–1996, almost doubling the corresponding figure for real wages in far more profitable COEs. Indirect wages followed a similar trend.

which may be considered to have lasted up to the early 1990s. Particular attention has been devoted to the measurement of a single indicator, total factor productivity (TFP).[84]

B. Studies on TFP growth

Estimates of TFP growth for the entire Chinese economy, carried out with different methodologies, are consistent in showing a sustained rate of technical progress – a very high rate for international standards. Hu and Wang (1999) present a growth accounting exercise on the whole Chinese economy for the period 1978–1995, with the main goal of pinpointing the origin of uneven development among the various Chinese provinces. Their results show that the main source of GDP growth has been the accumulation of physical capital and that the contribution of technical progress has been very uneven from one province to another. However, in global terms, "the contribution of technical progress … contributed more to output growth in China than in East Asian and Latin American NIEs" (idem.: 152).[85] According to the most recent World Bank estimate, the average TFP growth rate in China during 1980–1995 was 4 per cent, by far the highest of a sample including also the Republic of Korea and four other fast-growing Asian countries, as well as the United States, the world technological leader.[86] The conclusions of Jefferson and Singh (1999), a synthesis of the most relevant findings of many years of World Bank research on China's industry, also point in the same direction.

The evaluation of trends in technical progress in the state-owned industrial sector has led to less clear-cut results.[87] Chen et al. (1988) estimate productivity trends in the SOE sector, and find an increasing, long-term trend, which was appreciably strengthened by the reforms in the 1980s. According to a World Bank (1992) estimate, in 1980–1988 TFP in SOEs grew on average by 2.4 per cent per year. Other studies by Jefferson et al. (1992), Perkins (1995), and Li (1997)[88] find quite respectable rates of TFP growth in the 1980s.

However, other analysts, such as McGuckin et al. (1992), Chow (1993) and Woo et al. (1994) go as far as denying any TFP increase in state industry, even after the inception of the reforms. Wan (1995) measures technical progress in state industry and finds a long-run positive trend hampered by major

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[84] According to theory, TFP growth can also arise from gains in allocative efficiency, including scale economies. As the definition of technical progress adopted in this paper is a broad one (see the Introduction), encompassing *inter alia* changes in production organization, and taking into account that pure textbook-like allocative changes in static, ceteris paribus situations are hard to identify in real-life economic situations, TFP growth can be considered as a proxy for the rate of growth of technical progress. Yet, the informational value of TFP growth might have been overstated in the literature, and its theoretical weaknesses, related to its neoclassical conceptual base, are rarely taken into account. Moreover, TFP estimates can lack robustness, leading to contradictory results (Felipe, 1999, and section VI..D below).

[85] The authors acknowledge that, owing to the residual nature of technical progress in their analytical approach, its contribution might have been overstated, as is often the case in Solow-type growth accounting exercises.

[86] See World Bank (2000b, table 7.1). Estimated TFP growth rates were, respectively, 2.1, 1.3 and 0.3 for the Republic of Korea, the six Asian economies on average, and the United States. The extremely high estimate for China includes, according to the World Bank methodology, a component (1.5 per cent) stemming from sectoral reallocation and ownership changes. Even if this specific component were excluded, the residual TFP rate (2.5 per cent) for China would still be the highest of the sample.

[87] As detailed data on industrial performance are not yet available for the late 1990s, the quantitative debate has focused mainly on TFP estimates based on series which do not go beyond the 1980s.

[88] Li analyses a panel data set of 272 SOEs over the 1980–1989 period.

setbacks in correspondence to periods of political turmoil, such as the Great Leap Forward and the cultural revolution.[89] He also reviews previous studies, observing that his own results are quite similar to those obtained by Jefferson et al. (1992). Wan argues that the pessimists were more far off the mark than the optimists, but his estimates show a less than expected impact of the reforms.[90]

Wu (1995) proposes a different methodology, distinguishing TFP growth into two (additive) components, technological progress and changes in technical efficiency, the latter being the efficiency with which the existing technology is applied to production. Wu estimates the rate of growth of technical progress in three sectors (state industry, or SOEs), rural industry (roughly identifiable with rural COEs), and agriculture. He recalls the well-known structural differences between the two main industrial sectors: rural industry lacks access to first-class capital and technology, and often "uses machinery and equipment written off and transferred from the state sector" (idem.: 210). The result of this symbiotic relation is ambiguous, because rural industry can often turn its technological disadvantage into a significant cost advantage, which will be reflected in measured productivity growth. Wu's results show that TFP did grow, albeit unevenly among sectors. Technical progress appears to dominate technical efficiency, i.e. the production frontier keeps shifting upwards, while the efficiency gap mostly remains.[91]TFP growth was notably higher in rural industry than in state industry and agriculture, mainly due to the contribution of the technical progress component.[92]

Differences in results stem mainly from the use of different data sources and statistical methodologies, and in particular from the different deflators applied to inputs and outputs. Actually, Lo (1999) re-examines the same data used by Woo et al. (1994) and reaches a quite different conclusion: SOEs recorded a modest but positive rate of TFP growth in 1980–1992. On average, TFP growth rates in SOEs were much lower than in COEs, but in the LME subsector of state-owned industry TFP growth was even faster than in the collective industry. Especially after the publication of a second influential study by Jefferson et al. (1996), the general impression is that SOEs as a whole did experience a significant degree of technical upgrading and productivity increase. The most recent estimate by Jefferson et al. (1999) reaches the conclusion that TFP in state industry grew at a rate ranging from 2 to 4 per cent per annum in the 1980–1992 period, about half the rate achieved by the non-state sector, but still a positive achievement. The accumulation of less systemic evidence in the second half of the 1990s points in the direction of a continuing upward trend. But it is also clear that performance has been highly uneven among different groups of SOEs, and that their overall financial situation continued to deteriorate well into the late 1990s.

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89 In China more than elsewhere "nothing is unconnected to politics … technology diffusion and adoption are slower in an uncertain economic or political environment" (Wan, 1995: 315–317).

90 Wan's data stop at 1988 and thus fail to measure the impact, if any, of the new SOE reforms carried out in the 1990s.

91 An exception appears in agriculture in the mid-1980s, the period in which the implementation of the new HRS produced a once-and-for-all gain in technical efficiency (see note 51).

92 Wu's estimates also show a declining trend in technical progress and TFP growth in the SOE sector. However, the author's data do not cover the most recent period since the early 1990s, when SOE reforms intensified and might have been expected to lead to an amelioration.

C. Production and productivity growth in China's industry, 1980–1999

Recent data published in the *China Statistical Yearbook 2000* (referred to as SSB 2000, as it was issued by the State Statistical Bureau) illustrate the main trends in industrial production and employment. For SOEs in particular (the only group of industrial enterprises for which consistent investment data are readily available), these figures also allow for an elementary but updated estimate of a "residual", which could be interpreted as a proxy for the growth of TFP.

During the 20-year period 1980–1999, overall industrial production increased at an average (arithmetic) annual rate of 15 per cent. Industrial growth was faster in COEs (over 15 per cent per year on average) than in SOEs (7 per cent), and even faster in the residual group of industrial firms formed

Table 12
China's industry: basic data, 1980–1999s

	Year	*SOEs*	*COEs*	*Others*	*Total*
Real GDP	1980	392	121	2	515
Billions of yuan	1990	1270.5	856.7	246.5	2373.8
	1995	2834.8	3620.7	2795.5	9251.1
	1999	3657.9	4847.4	5666.8	14172.1
Average rate of growth	1980–99	6.99	19.13	42.7	15.1
Employment (millions)	1980	33.3	17.1	16.7	67.1
	1990	43.6	34.0	19.4	97.0
	1995	44.0	37.1	28.9	109.9
	1999	24.1	32.1	34.4	90.6
Labour productivity	1980	11.8	7.1	0.1	7.7
(thousands of yuan, 1980)	1990	29.1	25.2	12.7	24.5
	1995	64.5	97.7	96.8	84.2
	1999	151.7	151.2	164.6	156.4
Investment	1980	41.0	--	--	--
(billions of yuan, 1980)	1990	170.2	--	--	--
	1995	411.3	--	--	--
	1999	472.0	--	--	--

Sources: SSB (2000).

by "individual enterprises" plus all the remaining non-homogenous enterprises classified officially as "others"[93] (over 40 per cent)[94] (see table 12 and figure 1). Employment and labour productivity trends are

[93] It is important to stress that the group "others" also comprises, along with purely private firms (both Chinese and foreign-owned), several enterprises characterized by a mixed form of ownership, which in recent years have multiplied and are among the most advanced and faster-growing in the country's industrial sector (see section V). Therefore, these data have to be taken with a pinch of salt, as they might wrongly lead to subestimating both the relative weight and the performance of public ownership and entrepreneurship in Chinese industry.

[94] This extraordinarily high figure results statistically from the virtually zero base from which (recorded) individual and other enterprises' productive activities started in the early 1980s (see table 12).

shown in table 12 and figures 2 and 3. The large fall in SOE employment in the late 1990s is particularly striking. As SOE production did not decrease correspondingly, labour productivity in this group of enterprises, which had been lagging behind that in the other two groups, recovered strongly in the late 1990s. By 1999 average labour productivity in SOEs was slightly higher than in COEs and not much lower than in individual and other enterprises[95] (see table 12 and figure 3). Investment growth in SOEs was sustained over most of the period but slowed down in the second half of the 1990s (see table 12 and figure 4).[96]

D. Estimating the "residual" factor contributing to the growth of labour productivity in SOEs

Our estimate of the growth residual in SOEs is based on assuming that the basic factor driving the growth of production is the growth of investment, especially in a growing developing economy like China. Therefore, normalizing for labour, we posit a functional relation between the rate of growth of labour productivity per employee (*grY/L*) and the rate of growth of the investment/labour ratio (*grI/L*):

$$gr\ (Y/L) = f\ (grI/L) \qquad (1)$$

This assumption differs from the orthodox one based on the production function, the main arguments of which are the two main production factors, capital and labour.[97] The latter is not immune from theoretical problems and shortcomings, stemming in part from its direct derivation from the neoclassical theory and in particular from the latter's concept of capital (see footnote 84; also Felipe, 1999; Hulten, 2000; Barro and Sala-I-Martin, 1995a). Our alternative approach assumes a functional relation between two easily identified quantities measured in value (output and investment per worker, respectively). Hence, it avoids the difficulties implied by the dubious attribution of the same "production factor" property to both labour and capital, upon which is based the attempt to measure in a symmetrical fashion their respective contribution to output in the neoclassical production function approach. However, the main advantage of our alternative approach stems from the practical difficulty of obtaining an estimate of the capital stock, while data on investment are more readily available.[98]

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[95] As explained elsewhere in this section and in section V, these averages mask large differences in labour productivity internal to each ownership group. Many SOEs, mainly among the small ones, are plagued by low productivity, but the subgroup of state-owned LMEs comprises a large share of China's most technologically advanced and productive industrial enterprises. Even if some large and advanced COEs also exist, the bulk of non-SOE highly productive enterprises are either joint ventures or fully (foreign-owned) private firms, belonging to the residual "other" ownership group. Conversely, most individual industrial enterprises are relatively efficient, but small, and their technological and productivity levels are low.

[96] Data on GDP and investment in industrial SOEs in constant 1980 prices have been obtained from data in current prices applying the implicit deflator obtained from the series of real GDP growth rates by ownership groups of sectors of industrial enterprises. This simplified procedure necessarily implies ignoring the issue of attempting to estimate different deflators for industrial output and investment goods respectively, which was at the source of some of the differences in results in the studies on SOEs' TFP growth discussed above in this section.

[97] By itself, however, our simplified empirical assumption is not incompatible with a production function-based theoretical approach.

[98] A very similar methodology has been applied recently by Lin and Liu (2000: 8) in an exercise aimed at testing the impact of fiscal decentralization on growth in different provinces of China, using " the growth rate of per capita investment, in real terms, in fixed assets as a proxy for the growth rate of capital".

Figure 1

Industrial GDP

(Billions of yuan 1980)

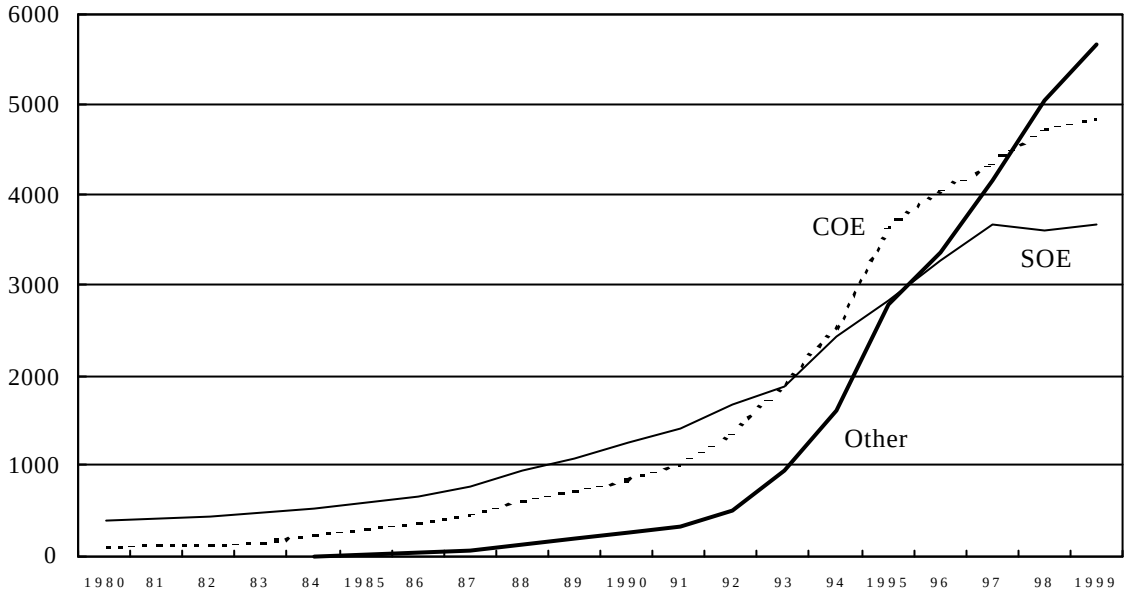


Figure 2

Employment in industry

(Millions)

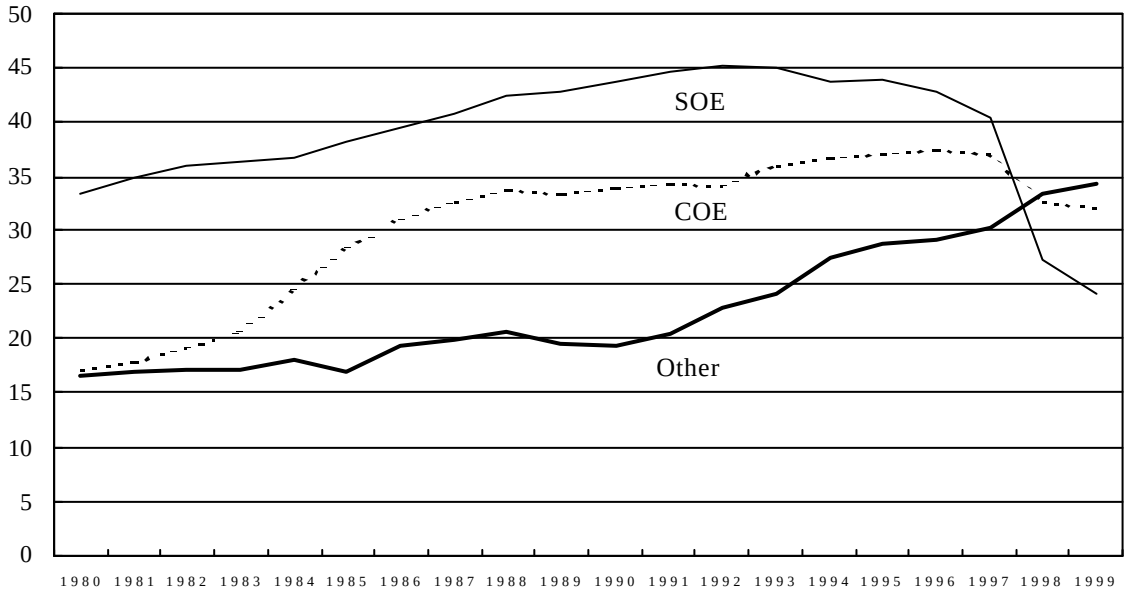


Figure 3

Labour productivity in industry

(Thousands of yuan 1980)

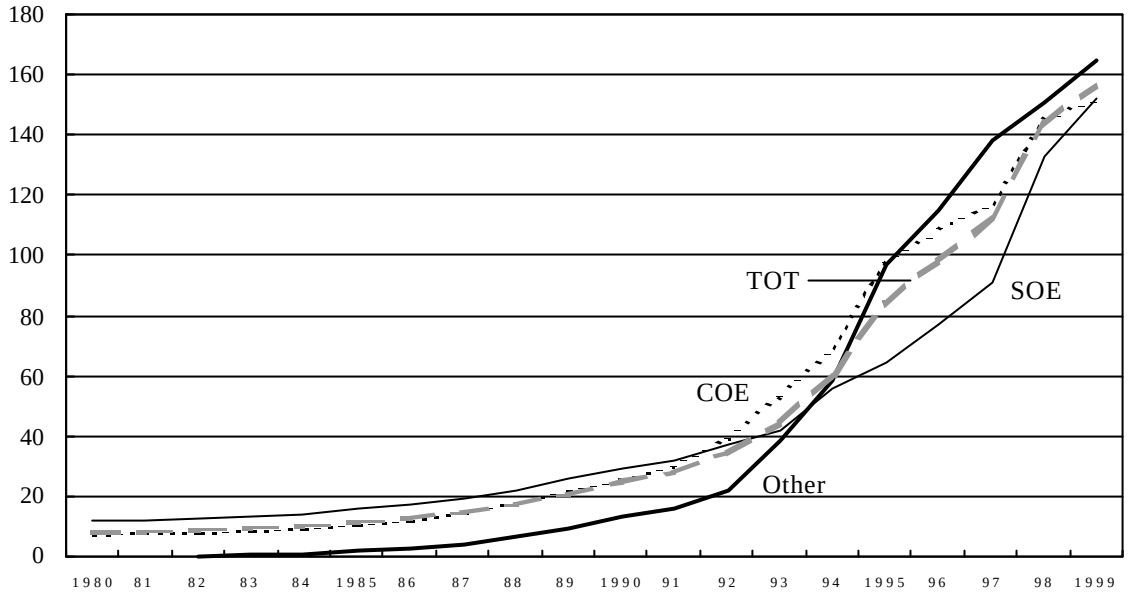
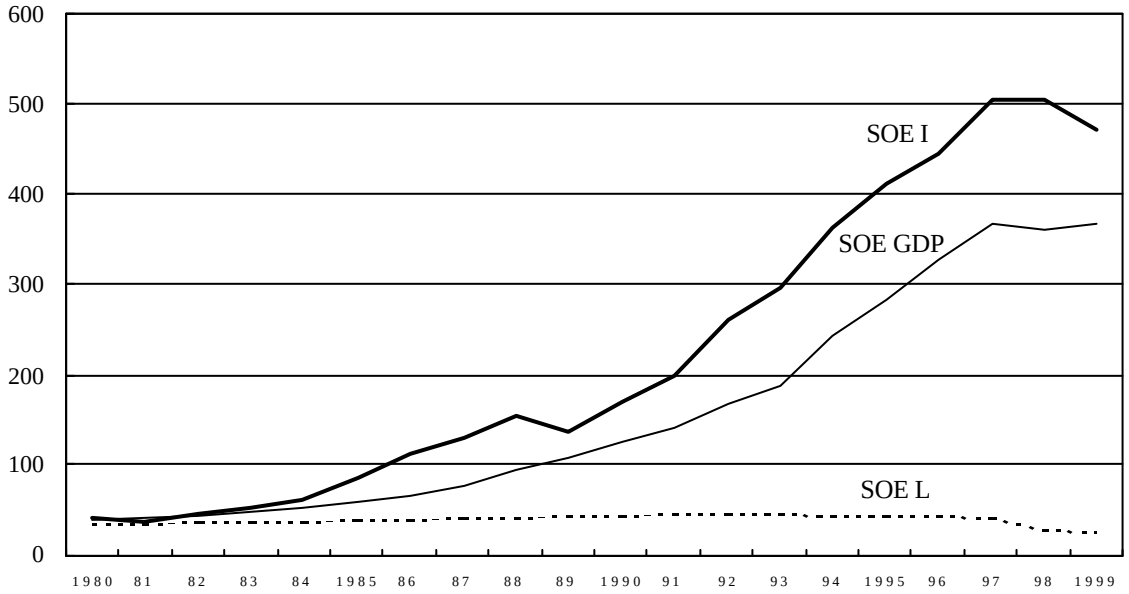


Figure 4

Industrial SOEs – GDP (10 billions 1980), labour (millions) and investment (millions 1980)



Assuming a linear functional form

$$gr\ (Y/L) = \alpha + \beta\ (gr I/L) + \varepsilon \qquad (2)$$

(where ε is the error term), the intercept *c* can be interpreted as the (annual growth rate of) the sum of all the residual factors, different from the growth in the investment per employee, which contributed to the growth of labour productivity.[99] Besides technical progress in the broadest possible sense, and thus embodying as well the gains stemming from improved X-efficiency, c is fuelled, for instance, by increases in human capital.[100]

The estimate of equation (2) for industrial SOEs over the period 1980–1999 led to theory-consistent coefficient signs and significant values of the *t* and *f* statistics.[101] However, the *R*-square was not very high, and the value of the *DW* statistics indicated the presence of autocorrelation (see table 13). As data on labour productivity show that a strong improvement took place in the second half of the 1990s (see figure 3), a dummy variable (*d94*) was introduced, with values *1* one in the 1994–1999 subperiod and zero for the preceding years. The presence of the dummy also allows for testing for the hypothesis of a major impact on productivity stemming from the latest round of reforms, which started actually around 1994 (see section V). The presence of the *d94* dummy, which turned out to be positive and highly significant, markedly improved the regression results[102] (see regression (b) in table 13). We conclude tentatively that the results of our simple exercise, based on very aggregate and basic data, provide support to the two following propositions. First, over the entire period of 1980–1999 the growth in industrial SOE labour productivity was attributable to a significant extent to a set of factors different from the increase in investment per employee, among which technical progress is likely to have been paramount. Second, the impact of these productivity-enhancing factors increased strikingly in the latest 1994–1999 subperiod. Our data, however, do not allow to disentangle which portion of these productivity gains is attributable merely to the dramatic labour shedding which took place in that subperiod, and which could rather be attributable to sustainable systemic improvements stemming from the intensification of industrial enterprise reforms.

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[99] Owing to the simplified character of the regression specification, the interpretation of *c* as a catch-all proxy for all non-capital factors contributing to output growth is likely to contain an upward bias, as it also captures a portion of the contribution to output growth stemming from the increase in the capital stock. In fact, even if gross investment data embody a share of investment funds which just replaces worn-out productive capacity, the rest under normal circumstances does contribute to the creation of new productive potential. Therefore, if gross investment were constant, or increased very slowly, the capital stock per worker would still be increasing, albeit at a declining rate (for instance, at an initial capital stock level of 100 and a constant investment level of 10), and its contribution to output could not be properly captured by the grI/L variable. However, in a scenario characterized usually by rapidly increasing investment rates, as that of China's industry, this statistical problem becomes less serious, and the growth of investment per worker can more reasonably be considered as a proxy for the growth of capital stock per worker.

[100] According to the very broad concept of technical progress described in the Introduction, gains in human capital accumulation may also be considered as a form of technical progress for a country as a whole.

[101] Estimates have been made using the ordinary least squares (OLS) method. As both variables are in the form of growth rates, the validity of these regression results is not contingent on the stationarity of the respective series in levels form.

[102] In the augmented regression, all explanatory variables are significant; the *R*-square and the *F* statistics are higher than in the previous model, and the *DW* statistic is close to 2.

Table 13
Regression results

	Variables	*Coeff.*	*t*	R^2	*DW*	*F*
(a) $gr(Y/L) = \alpha + \beta (grI/L) + \varepsilon$	--	--	--	0.35	1.1	9.3
	grI/L	0.43	3.04	--	--	--
	α	7.7	2.5	--	--	--
(b) $gr(Y/L) = \alpha + \beta (grI/L) + d94 + \varepsilon$	--	--	--	0.65	1.75	14.6
	grI/L	0.35	3.2	--	--	--
	α	5.3	2.2	--	--	--
	d94	11.9	3.6	--	--	--

Source: SSB (2000).

VII. CONCLUSIONS

This paper analyses some aspects of China's reformed and reforming S&T and industrial systems, which are related to the economy's overall capacity to absorb and generate technical progress and to transmit and spread it to the spheres of production and distribution. Our conclusion is that China's socialist economic system, after undergoing important and largely market-oriented reforms, appears tobe capable of driving a still developing economy towards an accelerated path not only of accumulation and quantitative growth, but also of broadly understood technical progress.

The present and future sustainability of this path is dependent upon the existence and evolution of various institutions which interact reciprocally through market and non-market relations, fostering the absorption of advanced technology from abroad and integrating it with a strong indigenous R&D effort. In this process, policy makers try to maximize the benefits potentially attainable from the growth of a yet embryonic domestic market for knowledge, the implementation of strategic technological programmes, and centralized state intervention in the key fields of industrial policies and of negotiations with TNCs.

After the initial success of agricultural reforms, this articulated strategy has so far been proceeding along with the reform of the dominant public sector of industry. In China, as elsewhere, enterprises are responsible for the application of internally and externally generated knowledge to practical production and distribution problems, and unless their behavioural functions are properly geared towards this key task, any S&T strategy would be inevitably doomed to ultimate economic failure.

COEs, which have enjoyed traditionally a high degree of autonomy and are strongly market-oriented, have been very successful. They increased their participation in total industrial output and appear set to absorb an important share of ailing, non-strategic SOEs. Their performance has been superior to that of SOEs as a whole also in qualitative terms, as they have achieved better financial results and higher rates of productivity and technical progress, while commanding far less measurable resources in terms of both physical and human capital. However, a more detailed analysis shows that the LMEs subsector of state industry have performed quite well. Technical progress in the high-technology sectors has been

concentrated in this industrial subsector. Hence, policy makers see the strengthening of large, technologically advanced SOEs as pivotal for the long-term overall development of the Chinese economy.

The proponents of a selective revamping of the SOE sector also point out that COEs have thrived mainly in those low and medium technological sectors which allow for the maximization of China's static comparative advantages. As these advantages stem from China's underdevelopment, their relevance is bound to diminish in the future if the country continues to move forward and catch up with more advanced countries. Moreover, part of COEs success has also been kind to a sort of trickling-down effect by virtue of which they acquired physical and human capital and technology from SOEs at below-market prices via cheap informal channels. Its sustainability is therefore to some extent dependent upon the existence and upgrading of more sophisticated technological capacities in the state-run industrial sector.

SOE reforms have focused initially on increased autonomy and market orientation and on the reshaping of the managers' behavioural function through the contract responsibility system. Since the mid-1990s emphasis has shifted towards the concentration of resources on a core of large strategic enterprises, which are believed to be capable of realizing economies of scale and scope and to be organizationally adequate to be the locus of the country's catching-up effort in high-technology sectors. To this purpose, on one hand, core SOEs are set to undergo a process of corporatization in the framework of a renewed and diversified system of public ownership. On the other hand, they are expected to maximize the advantages potentially obtainable through non-market channels from strategic state support in the fields of industrial policies, negotiations with TNCs, and horizontal collaboration with the national R&D system. According to present policy orientations, non-strategic SOEs will undergo a status transformation, and those which survive will cease to be part of the state sector. However, even taking into account a certain degree of acceleration in the late 1990s, the reform process in the state-owned industrial sector is proceeding slowly and gradually, due to its delicate social and political implications.

The overall sustainability of this complex development path necessarily requires a high degree of market compatibility, with respect to the transformation and circulation of commodities (knowledge included), and of incentive compatibility, with respect to the behavioural patterns of the various economic agents. The bulk of technical innovations and imitations generated and acquired as forms of economically relevant knowledge must eventually lead to the production and commercialization of more advanced and/or cheaper commodities for which a real domestic or foreign market does exist. Planners, managers and workers must face an adequate incentive system as individuals, and the institutions and organizations in which they work, as collective bodies, must as well be confronted with incentives conducive to virtuous behavioural responses.

The experience of the last two decades shows that China's reformers have been able so far to achieve innovative and feasible (although imperfect and often unsystematic) solutions to the aforementioned problems, within the framework of a continuously evolving regime of socialist property relations. The present direction of S&T and enterprise reform policies, with their emphasis on the acceleration of technical progress in high-technology core sectors, appears to be moving in the right direction.

REFERENCES

Abramovitz M (1989). *Thinking About Growth, and Other Essays on Economic Growth and Welfare*. Cambridge, Cambridge University Press.

Amsden AH (1989). *Asia's Next Giant: South Korea and Late Industrialization*. New York and Oxford, Oxford University Press: xvi, 379.

Aoki M (1990). A new paradigm of work organization and co-ordination? In: Marglin SA and Schor JB, eds. *The Golden Age of Capitalism: Reinterpreting the Postwar Experience*. WIDER Studies in Development Economics. Oxford, New York, Toronto and Melbourne, Oxford University Press and Clarendon Press: 267–293.

Archibugi D, Howells J and Michie J, eds. (1999). Innovation systems and policies in the global economy. *Innovation Policy in a Global Economy*. Cambridge, Cambridge University Press: 1–18.

Arrow KJ (1962). The economic implications of learning by doing. *Review of Economic Studies*, XXIX: 155–173.

Baark E (1992). *Fragmented Innovation: China's Science and Technology Policy Reforms in Retrospect*. In: Congress of the United States, Joint Economic Committee, ed. *China's Economic Dilemmas in the 1990s: The Problems of Reform, Modernization and Interdependence*. Armonk, NY, ME Sharpe.

Barro R and Sala-I-Martin X (1995a). *Economic Growth*. New York, London and Montreal, McGraw-Hill: xviii–539.

Barro R and Sala-I-Martin X (1995b). Technological diffusion, convergence and growth. NBER Working Paper Series 5151. Cambridge, MA, National Bureau of Economic Research, June: 43.

Bayoumi T, Coe D and Helpman E (1999). R&D spillovers and global growth. *Journal of International Economics*, 47, April: 399–428.

Boratav K, Gabriele A and Parikh A (2000, forthcoming). Instability and volatility of capital flows to developing countries. *The World Economy*.

Brenner R (1987). Rivalry. *Business, Science, Among Nations.* New York, Cambridge University Press: xi, 244.

Broadman H (1999). The Chinese state as a corporate stakeholder. *Finance and Development* 36(3), September: 52–55.

Buckley PJ, Casson M and Dunning J, eds. (1992). Multinational Enterprises in the World Economy. In: Buckley PJ and Casson M, eds. *Essays in Honour of John Dunning*. Aldershot, UK, and Brookfield, US, Edward Elgar.

Byrd W and Lin Q, eds. (1990). China's rural industry: An introduction. *China's Rural Industry: Structure, Development and Reform*. New York, Oxford University Press.

Chang P, ed. (1996). *The State Science and Technology Commission*. Beijing, Scientific and Technical Documents Publishing House, Beijing: 52.

Chen K, Jefferson G, Rawski T, Wang H and Zheng Y (1988). Productivity change in Chinese industry. *Journal of Comparative Economics* 12(4), December.

Chen H and Rozelle S (1999). Leaders, managers and the organization of township and village enterprises in China. *Journal of Development Economics* 60: 529–557.

Chesnais F (1995). Convergence and divergence in technology strategies. In: Hagerdoorn J, ed. *Technical Change and the World Economy: Convergence and Divergence in Technology Strategies*. Aldershot, UK, Edward Elgar: 6–33.

Chow G (1993). Capital formation and economic growth in China. *Quarterly Journal of Economics* 108(3), August: 809–842.

Coase RH (1960). The problem of social cost. *Journal of Law and Economics* 3, October: 1–44.

Coe TD and Helpman E (1995). International R&D spillovers. *European Economic Review* 39: 859–887.

Cohen WM and Levinthal DA (1989). Innovation and learning: The two faces of R&D. *The Economic Journal* 99(397), September: 569–96.

Cohen WM and Levinthal DA (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35: 128–152.

Dosi G (1999). Some notes on the national systems of innovation and production, and their implications for economic analysis. In: Archibugi D, Howells J and Michie J, eds. *Innovation Policy in a Global Economy*. Cambridge, Cambridge University Press: 35–48.

EIU (1999). *China-Country Report, 4st Quarter*. Beijing, Economist Intelligence Unit.

EIU (2000). *China-Country Report, 1st Quarter*. Beijing, Economist Intelligence Unit.

Estrella Tolentino P (1993). *Technological Innovation and Third World Multinationals*. London and New York, Routledge: xxii–458.

Eyraud C (1999). *L'entreprise d'Etat chinoise – De "l'institution sociale totale" vers l'entité economique?* Paris and Montreal, L'Harmattan: 398.

Fan X (1999). How spillovers from FDI differ between China's state and collective firms. *MOCT-MOST* 1: 35–48.

Feenstra RC (1996). Trade and uneven growth. *Journal of Development Economics* 49(1), April: 229–256.

Feigenbaum EA (1999). Who's behind China's high technology "revolution"? – How bomb makers remade Beijing's priorities, policies and institutions. *International Security* 24(1): 95–126.

Felipe J (1999). Total factor productivity growth in East Asia: A critical survey. *Journal of Development Studies* 35(4): 1–41.

Freeman C (1987). Technology policy and economic performance: Lessons from Japan. London and New York, Francis Pinter: 155.

Gao S and Yao Y (1999). Implementation of socially optimal outcomes in the liquidation of public enterprises in China. *China Economic Review* 10(1): 41–58.

Ge W (2000). Financial sector restructuring and the capital account management in China: Some lessons for economic integration (mimeo). Lewisburg, PA, Department of Economics, Bucknell University.

Grow R (1993). In search of excellence in China's industrial sector: The Chinese enterprise and foreign technology. In: Congress of the United States, Joint Economic Committee, ed. *China's Economic Dilemmas in the 1990s: The Problems of Reform, Modernization and Interdependence*. Armonk, NY, ME Sharpe: 817–827.

Hsieh W-J (1994). Technology transfers to China: A path to growth different from Japan. *Rivista Internazionale di Scienze Economiche e Commerciali* 41(9): 797–812.

Hu A. and Wang S (1999). *The Political Economy of Uneven Development: The Case of China*. Armonk, NY, ME Sharpe: xii–276.

Huang J and Rozelle S (1996). Technological change: Rediscovering the engine of productivity growth in China's rural economy. *Journal of Development Economics* 49(2): 337–369.

Huang Y, Woo WT and Duncan R (1999a). Understanding the decline of China's State sector. *MOCT-MOST* 9: 1–15

Huang Y, Woo WT and Duncan R (1999b). Did competition drive down the profitability of China's state-owned enterprises? *MOCT-MOST* 9.

Hulten CR (2000). Total factor productivity: A short biography. NBER Working Paper 7471. Cambridge, MA, National Bureau of Economic Research, January.

Jefferson G (1998). China's state enterprises: Public goods, externalities and Coase. Papers and Proceedings from the 110th Annual Meeting of the American Economic Association. *American Economic Review* 88(2): 428–432.

Jefferson G, Mai L and Zhao ZQ (1999). Reforming property rights in China's industry. In: Jefferson G and Singh I, eds. *Enterprise Reform in China – Ownership, Transition and Performance*. A World Bank Research Publication. New York, Oxford University Press: 107–126.

Jefferson G and Rawski T (1999). China's industrial innovation ladder: A model of endogenous reform. In: Jefferson G and Singh I, eds. *Enterprise Reform in China – Ownership, Transition and Performance*. A World Bank Research Publication. New York, Oxford University Press.

Jefferson G, Rawski T and Yuxin Z (1992). Growth, efficiency and convergence in China's state and collective industry. *Economic Development and Cultural Change* 42(2), January: 239–266.

Jefferson G, Rawski T and Yuxin Z (1996). Chinese industrial productivity: Trends, measurement issues and recent developments. *Journal of Comparative Economics* 23(2), October: 146–180.

Jefferson G, Rawski T and Zheng Y (1997). Innovation in Chinese manufacturing enterprises: A preliminary analysis of survey data. *MOCT-MOST* 7(4): 101–120.

Jefferson G and Singh I, eds. (1999). *Enterprise Reform in China – Ownership, Transition and Performance*. A World Bank Research Publication. New York, Oxford University Press.

Jefferson G, Singh I, Jungling X and Shouquing Z ("et al.") (1999). China's industrial performance: A review of recent findings. In: Jefferson G and Singh I, eds. *Enterprise Reform in China – Ownership, Transition and Performance*. A World Bank Research Publication. New York, Oxford University Press: 127–152.

Kaldor N (1957). A model of economic growth. *Economic Journal* 67, December: 591–624.

Kanter RM (1983). *The Change Master: Innovation for Productivity in the American Corporation*. New York, Simon and Schuster.

Keller W (1996). Absorptive capacity: On the creation and acquisition of technology in development. *Journal of Development Economics* 49, April: 199–227.

Knell M and Radosevic S (2000). FDI, technology transfer and growth in economic theory. In: Hunya G, ed. *Integration Through FDI: Making Central European Industries Competitive*. Cheltenham, UK, Edward Elgar: 28–49.

Kinoshita Y (1999). Technology spillovers through foreign direct investment. Working Paper 221. Ann Arbor, MI, William Davidson Institute, University of Michigan Business School.

Li D (1996). A theory of ambiguous property rights in transition economies: The case of the Chinese non-state sector. *Journal of Comparative Economics* 23(1): 1–19.

Li W (1997). The impact of economic reform on the performance of Chinese state enterprises: 1980–1989. *Journal of Political Economy* 105(5): 1080–1106.

Lin, JY, Cai F and Li Z (1999). Fair competition and China's state-owned enterprises reform. *MOCT-MOST: Economic Policy in Transitional Economies* 9(1): 61–74.

Lichtemberg FR (1992). R&D investment and international productivity differences. NBER Working Paper 4161. Cambridge, MA, National Bureau of Economic Research, September: 1–37.

Lin JY and Liu Z (2000). Fiscal decentralization and economic growth in China. *Economic Development and Cultural Change* 49(7), October: 1–21.

Lo D (1999). Reappraising the performance of China's state-owned enterprises, 1980–96. *Cambridge Journal of Economics* 23(6): 693–718.

Lucas R (1990).Why doesn't capital flow from rich to poor countries? *American Economic Review* 80(20): 92–96.

Lundvall BA, ed. (1992). *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London, Francis Pinter: xiii–342.

Ma K and Zhao Y (1993). Technical development and innovation work develops universally among China's large and medium industrial enterprises. *Zhongguo Tongji* 4(10).

McGuckin RH et al. (1992). Post-reform productivity performance and sources of growth in Chinese industry, 1980–1985. *Review of Income and Wealth* 38(3): 249–266.

Miller HL (1996). *Science and Dissent in Post-Mao China – The Politics of Knowledge*. Seattle and London, University of Washington Press.

Murakami N, Liu D and Otsuka K (1994). Technical and allocative efficiency among socialist enterprises: The case of the garment industry in China. *Journal of Comparative Economics* 19(3): 410–433.

Murakami N, Liu D and Otsuka K (1996). Market reform, division of labour and increasing advantage of small-scale enterprises: The case of the machine-tool industry in China. *Journal of Comparative Economics* 23(3): 256–277.

Naughton B (1994). What is distinctive about China's economic transition? State enterprise reform and overall system transformation. *Journal of Comparative Economics* 18(3), June: 470–490.

Nelson RR, ed. (1993). *National Innovation Systems. A Comparative Analysis*. Oxford, NY, Toronto and Melbourne, Oxford University Press: x–541.

Nelson RR and Pack H (1999). The Asian miracle and modern growth theory. *Economic Journal* 109, July: 416–436.

Nichols T and Zhao M (1996). Management control of labour in state-owned enterprises: Cases from the textile industry. *China Journal* (Australia) 36, July: 1–21.

Nolan P (1996). Large firms and industrial reform in former planned economies: The case of China. *Cambridge Journal of Economics* 20: 1–29.

Nolan P (1999a). Strategic choices in the development of the Chinese coal industry: The case of the Shenhua Group (mimeo). Cambridge, University of Cambridge.

Nolan P (1999b). Globalization, big business and catch-up in developing countries (mimeo). Cambridge, University of Cambridge.

Nolan P (1999c). AVIC – Internationally competitive aircraft manufacturer, diversified Asian conglomerate or global sub-contractor? (mimeo). Cambridge, University of Cambridge.

Nolan P and Wang X (1999). Beyond privatization: Institutional innovation and growth in China's large state-owned enterprises. *World Development* 27(1): 169–200.

OECD (1998). *Science, Technology and Industry Outlook*. Paris, Organisation for Economic Co-operation and Development.

OECD (2000). *Reforming China's Enterprises*. Paris, Organisation for Economic Co-operation and Development: 130.

Perkins DH (1995). The transition from central planning: East Asia's experience. In: Koo BH and Perkins DH, eds. *Social Capability and Long-term Economic Growth*. New York, St. Martin's Press; London, Macmillan Press: 221-241.

Porter M (1990). *The Competitive Advantage of Nations*. New York, Free Press: xx–855.

Rodriguez-Clare A (1996). The division of labor and economic development. *Journal of Development Economics* 49, April: 3–32.

Sicular T (1995). Why do state-owned enterprises choose to make a loss? Economic Research Journal 5 (in Chinese).

Solow R (1960). Investment and technical progress. In: Arrow KJ, Karlin S and Suppes P, eds. *Mathematical Methods in Social Sciences* (1959). Stanford, CA, Stanford University Press: 84–104.

SSB (State Statistical Bureau of the People's Republic of China) (2000). *China Statistical Yearbook 2000*. Beijing, Statistical Information and Consultancy Service Centre.

Suttmeier R (1993). China's high technology: Programs, problems and prospects. In: US Congress Joint Economic Committee. *China's Economic Dilemmas in the 1990s: The Problems of Reforms, Modernization and Interdependence. Studies on Contemporary China*. Armonk, NY, ME Sharpe: 546–564.

Suttmeier RP and Cao C (1999). China faces the new industrial revolution: Achievements and uncertainty in the search for research and innovation strategies. *Asian Perspectives* 23(3): 153–200.

Tam K (1999). *The Development of Corporate Governance in China*. Cheltenham, UK, and Northampton, MA, Edward Elgar: xii–129.

UNCTAD (1997). *Trade and Development Report 1997*. United Nations publication, sales no. E.97.II.D.8. New York and Geneva, United Nations Conference on Trade and Development.

UNCTAD (1998). *Trade and Development Report 1998*. United Nations publication, sales no. E.98.II.D.6. New York and Geneva, United Nations Conference on Trade and Development.

UNCTAD (1999a). *Trade and Development Report 1999*. United Nations publication, sales no. E.99.II.D.1. New York and Geneva.

UNCTAD (1999b). *World Investment Report 1999*. United Nations publication, sales no. E.99.II.D.3 New York and Geneva.

UNCTAD (2000a). *UNCTAD Handbook of Statistics 2000*. United Nations publication, sales no. E.00.II.D.39. New York and Geneva.

UNCTAD (2000b). *World Investment Report 2000*. United Nations publication, sales no. E.00.II.D.20. New York and Geneva.

UNDP (2000). *Human Development Report 2000*. United Nations publication, sales no. 00.III.B.8. New York, United Nations Development Programme.

Wan GH (1995). Technical change in Chinese state industry: A New Approach. *Journal of Comparative Economics*, 21(3): 308–325.

Wang X (1990). Capital formation and utilization. In: Byrd WA and Lin Q, eds. *China's Rural Industry: Structure, Development and Reform*. Oxford, New York, Toronto and Melbourne, Oxford University Press for the World Bank: 222–242.

Woo WT et al. (1994). How successful has Chinese enterprise reform been? Pitfalls in opposite biases and focus. *Journal of Comparative Economics* 18(3), June: 410–437.

World Bank (2000a). *World Development Report 2000–2001*. Washington, DC.

World Bank (2000b). *East Asia – Recovery and Beyond*. Washington, DC, May: 158.

Wu Y (1995). Productivity growth, technological progress and technical efficiency change in China: A three-sector analysis. *Journal of Comparative Economics* 21(2): 205–229.

Wu Y (2000). Reconstruction of the sphere of China's telecommunication industry. Interview with a reporter from *Finance* magazine, republished in *China's Foreign Trade*, February: 14–17.

Xu X and Wang Y (1999). Ownership structure and corporate governance in Chinese stock companies. *China Economic Review* 10(1): 75–98.

Young S and Lan P (1997). Technology transfer to China through foreign direct investment. *Regional Studies* 31(7): 669–679.

Yu QY (1999). The implementation of China's science and technology policy. *Quorum Books*. Westport, Conn., and London: xv,238.

ANNEX

Recent developments in industrial reforms and S&T policies[103]

A. Measures to rein in SOEs' financial losses

The accumulation of evidence on the less than satisfactory performance of many SOEs, even during a time of sustained industrial expansion for the economy as a whole, has added to the urgency of acting swiftly to tackle the sector's serious financial problems and to translate into practice the slogan "grasp the big, enliven the small". During 1999 SOEs' output kept growing, but the problem of overproduction by many SOEs continued to persist, and their exports fared poorly.[104] In the meantime, the structural, largely social and political, as well as institutional causes of many problems of SOEs were also becoming increasingly evident. A recent study by the Chinese Academy of Social Sciences confirms that SOEs spend excessively for workers' welfare. By 1995, 28 per cent of the fixed assets of SOEs had been diverted for non-business purposes, compared to 10 per cent for other types of firms. Average social welfare expenditure per worker was 3,350 yuan in SOEs (58 per cent of wages), against 1,070 in COEs. Without this excessive welfare expenditure, most SOEs would actually not be losing money. In fact, the value of new, fixed, non-productive investment by money-losing heavy SOEs was equal to 97.83 per cent of their losses (*China Daily*, 1 February 2000).

Stern measures to deal with SOE losses intensified in 1998–1999. Bankruptcies and closures of money-losing SOEs were mushrooming. By August 1999 SOEs were 48,200, down from 56,100 in late 1998. The downsizing of the SOE sector is necessary both in the short term, in order to preserve basic macroeconomic and financial equilibria, and from a long-term development perspective, but it cannot be carried out in a hurried and indiscriminate fashion as it is causing the loss of millions of jobs, only some of which can be immediately replaced. As part of the overall reform process, and attempting to deal with such potentially explosive and conflicting goals, a plan of debt for equity swaps has been launched by the State Economic and Trade Commission (SETC). To be eligible, state enterprises must, on one hand, be losing money, but on the other hand they must be large and strategically relevant, and must show good market perspectives and internal restructuring potential. The plan, besides fostering the restructuring of potentially viable albeit financially troubled industrial enterprises, aims at freeing the banks of bad debts. To this purpose, SOE ownership is to be transferred to newly established asset management companies (AMCs), leaving the banks free to lend commercially on a business basis instead of acting passively under government order. If successful, this plan will constitute an important step forward in the overall process of institutional upgrading of industrial corporate governance, and will contribute to the modernization and autonomization of the banking sector.[105]

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[103] This Annex relies mainly on official Chinese statistical information, most of it produced by the State Statistical Bureau and the State Economic and Trade Commission, and is reported in various issues of the Economist Intelligence Unit reports, newspapers and on-line information networks.

[104] The bulk of SOE exports is still constituted of lower value-added traditional products in heavy industrial and consumer goods sectors, which are very susceptible to price competition that was particularly fierce in 1999 due to the incipient recovery of some battered Asian countries anxious to regain their footing in international markets. However, the state industry still contributes almost half of total Chinese exports, with most of the rest coming from foreign invested enterprises (Economist Intelligence Unit, 1999).

[105] Several other initiatives are being implemented to improve the regulation of the financial sector.

B. The revamping of SOEs' structural reforms

The reform process in the state-owned industrial sector underwent a retrenchment exercise in 1997–1998, as the government reacted cautiously to the relative slowdown and to the potential risks stemming from the Asian financial crisis. SOE reforms regained momentum in 1999, and were the main focus of the Fourth Plenum of the Fifteenth Central Committee, held in September of that year.

The Fourth Plenum confirmed the main policy lines on SOE restructuring. The state will continue to play the major role, but there will be an "effective method of public ownership" with mixed forms of ownership and joint stock companies. The state will concentrate on a limited core of LMEs, most of them in high-technology industries, encouraging non-state investors to take up the rest of presently existing SOEs. The remaining SOEs are expected to play a dominant role, and to this purpose they will be encouraged to also raise funds autonomously from domestic and foreign capital markets. Some large SOEs with listed shares will increase their non-state quota, but the majority will still be state-held. Part of the funds obtained through the capital market will contribute to the restructuring of other SOEs. Funds will also be increased to write off bad debts for banks, and to prepare the merger or bankruptcy of medium and large SOEs and the closure of money-losing mines. Among the SOEs operating in traditional, capital-intensive, resource-based fields, many are to be closed or will drastically reduce production, especially those in the sectors of coal, iron and sugar. Selected large state enterprises in the steel industry will be renovated technologically with ample funds (CBNet, January 2000). Reforms are also expected to improve corporate governance and gear SOEs operation more effectively towards the market, separating more clearly governmental functions from enterprise management. The internal distribution system of SOEs will be improved to make it more consistent with the modern enterprise system and to provide effective incentives.[106] SOEs are also encouraged to establish their own technological development centres, although the state will improve costs and product quality supervision.

The process of corporatization of large SOEs is gaining momentum. More than 800 large of them have listed stock on the market, becoming "joint-shareholding companies"; however, the state still holds a majority of shares.[107] High technology firms are being accorded a priority in this process, and have been allowed preferential conditions to enlist on the stock market.[108]

Many local governments are also taking the initiative to reform and upgrade technologically industrial enterprises. In Beijing, where an explosive growth of technology-based new enterprises is taking place, some SOEs are going to start setting autonomously their wage levels (*China Daily*, 2 February 2000). The government of Wuhan, capital of Hubei Province, decided to stop launching new totally state-owned SOEs, to diversify ownership and to concentrate state funds on high-technology industry, while withdrawing progressively from low-technology competitive industries (CBNet, December 1999).

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[106] Incentives for managers of profitable SOEs will include the option of buying shares, but these will not be tradeable and will be given to them only when they leave the company.

[107] China National Petroleum Corporation, the largest oil company, is the first in the sector to seek an international listing, with an initial public offering set at $7 billion, higher than Telecom's in Hong Kong (China) in 1997 ($4.2 billion). More than 20 large SOEs plan to list shares in Hong Kong (China), with the goal of raising funds for technological restructuring and to improve their competitiveness (*Financial Times*, 23 December 1999).

[108] Initially, industrial enterprises were allowed under different sets of rules to issue two different types of shares (A and B), for domestic and foreign investors respectively, but since September 1999 foreign-invested enterprises have been authorized to issue both types of shares.

Guandong Province is turning its R&D institutions into corporate entities, with workers encouraged to buy stakes in their companies (CBNet, September 1999).

Preliminary results appear to indicate that in 1999 the SOE sector as a whole began to show clear signs of improvement. By August the percentage of SOEs in the red was 50 per cent, down from 56 per cent by end 1998, 60 per cent of which were making only very small losses.[109] Staff cuts and management reform helped to lift SOE profits by 70 per cent in the whole of 1999, and valued added rose by 8.9 per cent. Annexing and bankruptcies became more widespread. The debt-to-equity conversion policy has been proceeding, with a total funding of 112.2 billion yuan. Two thousand out of 16,000 large and medium SOEs have applied, but only 601 have been selected so far. Technology renovation is also been implemented. Particularly encouraging financial results have been obtained by the machine tool industry, which plays a very important role for the technological development of the whole industrial sector. The industry turned profitable and grew again in 1998 and 1999, after five years of losses and decline. Domestic producers regained more than 50 per cent of the Chinese domestic market and increased exports in value by 14.5 per cent (SETC, reported in Economist Intelligence Unit, 1999 and 2000).

C. The restructuring of telecom industry and the national technology innovation conference

Along with the market-oriented reorganization of a large part of the SOE sector, the government has continued its policy of planned restructuring and technological upgrading in a few crucial, quasi-monopolistic, high-technology sectors of decisive strategic relevance, in which China has already established a firm foothold. Among them, the telecommunications industry is the most important. Policy makers and industrial leaders try to walk a fine line, striving to achieve an optimum degree of domestic competition and to increase the industry's attractiveness for technology-intensive FDI,[110] while maintaining a strategic command over the development of the sector.

China Telecom, a large SOE presently dominating the industry, is among the world's top 10 telecom companies. It already has one state-owned competitor, China Unicom, and a third one is soon to be launched. The new company, China Nectar Corporation, will focus on Internet protocol backbone services and international integrated data services.[111] It will be owned by the Chinese Academy of Sciences, The State Administration of Radio, Film and Television, the Ministry of Railways and the Shanghai Municipal Government, each with equal shares. This complex structure constitutes an interesting example of the modern, diversified form of public ownership which is proposed as a model for the restructuring of all core SOEs. The various telecom enterprises will enjoy substantial autonomy, while the Ministry of Information will remain in charge of supervision, coordination and planning tasks, including the orientation of technical progress, the formulation and implementation of industrial policies, and the regulation and surveillance of the market (Wu Jichuan, Minister of the Information Industry, 2000).

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[109] The financial improvement of the SOE sector is expected to continue during the first half of the present decade. The government hopes to rid state industry of major losses in a three-year period.

[110] The degree of control and ownership rights to be allowed to foreign investors in the telecom sector constitutes a controversial issue, which has been among the main topics in the negotiations held with the United States and the European Union in order to gain China's membership to WTO.

[111] To this purpose, a new optical fibre network is being set up. It will be the world's first IP-based optical fibre commercial network, with a bandwitch of 20 gigabits.

In the field of S&T policy proper, among the major recent initiatives a national technology innovation conference was held in August 1999. Policy orientation is favourable to the development of high-technology industries with strengthened intellectual property rights, with an important role for technology-based small and medium enterprises. Most research institutes should be turned into enterprises and enter market competition. To this end, preferential policies are being launched to give tax incentives to financially trapped research institutions. The tax incentives package is expected to accelerate the reform of the R&D system and to promote the industrialization of R&D findings (CBNet, August 1999).

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