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Abstract

The relationships between investment in R&D and productivity growth at sectoral level have been well documented in the literature. So far little research has been done on this topic for China, in part due to data limitations. This paper presents an empirical study of productivity growth and R&D at sectoral level in China's high-tech manufacturing industries. Using a version of the perpetual inventory method (PIM), new estimates have been made of the physical capital stock and the R&D stock by sector. Using a production function based on endogenous growth theory, we calculate the elasticities of output with respect to R&D stocks. The R&D stock of the electronic industry plays special role for the whole of the high-tech sector. The analysis points to spillovers from the electronic industries to other high-tech sectors. This is indicated by a significant positive influence of R&D in electronics on productivity growth in other high-tech industries.. Finally, we found that other technological inputs play a less important role in productivity growth, than the R&D stock.

1. Introduction

The high-tech sector[1] plays an important role in Chinese manufacturing and the Chinese economy. In 2001, value added in high-tech industries was 309.5 billion yuan RMB. Between 1998 and 2001, the share of high-tech industries in manufacturing GDP increased from 12 per cent to 14 per cent. Their share in total GDP increased from 2 to 3 per cent. From 1999 to 2001, the average growth of value added in high-tech industries was 20.5 per cent, 1.5 times as high as in manufacturing and nearly 3 times as high as in the whole economy. Meanwhile, China's high-tech industries also played an important role in exports. From 1995 to 2001, the share of high-tech industries in total exports increased from 9 to 19 per cent. The growth of high-tech exports reached 28 per cent, more than twice as high as the growth of total exports.

From the perspective of economic theory, it is interesting to study high-tech industry, because of the importance of technological change for growth performance. In the past decades, there have been some significant changes in theorising about economic growth. The traditional neoclassical model and its treatment of technological change as exogenous have gradually given way to more realistic approaches emphasizing innovation, scale economics and market power. This change of perspective was anticipated by John Cornwall (1977). He suggested a model of economic growth in which technological progress is endogenized. The manufacturing sector plays an key role in this context. Jan Fagerberg and Bart Verspagen (1999) found confirmation for Cornwall's argument that manufacturing was still an engine of growth in some fast-growing newly industrialized countries (NICs), as well as in other developing countries. Furthermore, they also found that the technologies that emerge from the new growth industries (especially electronics) are an import source of growth in many service industries.

In this paper, we examine the sources of growth in China's high-tech industries, focusing in particular on the relationships between R&D and labour productivity. Many econometric studies have pointed to the contribution of R&D activities to the productivity growth at firm and sectoral level. The main framework for this kind of studies is the Cobb-Douglas production function. Various versions of the model have been estimated by Griliches (1980, 1986,1995, 2000), Griliches and Mairesse (1984,1990), Schankerman (1981), Jaffe (1986), Cuneo and Mairesse (1984), Goto and Suzuki (1989), Hall and Mairesse (1995), Husso (1997) and Bartelsman et al. (1996) .

When we assess the impact of R&D on sectoral productivity, spillovers must be taken into account, including spillovers from electronic to non-electronic industries and from non-electronic industries to electronic industries; The most influential paper on spillovers is the paper by Coe and Helpman (1995).

The paper is organized as follows. In section 2, descriptive data on the Chinese high-tech manufacturing industries are presented. Section 3 describes the estimation of R&D stocks. In section 4, we discuss issues in the measurement of capital in the Chinese context. New preliminary estimates of the Capital Stock in high-tech sectors are made, according to the perpetual inventory method. In section 5, we include R&D stocks in a Cobb-Douglas production function along with traditional inputs such as labour and capital, in order to estimate the output elasticity of R&D in high-tech industries. We also analyze the influence of other technological inputs on productivity. The conclusions are summarised in section 6.

[1] The definition of high-tech industries in China is same as in OECD countries. The high-tech sector includes manufacture of medical and pharmaceutical products, manufacture of aircraft and spacecraft, electronic and telecommunications equipment, manufacture of computers and office equipment, manufacture of medical equipment and meters.

2. The Development of the High-Tech Manufacturing Sector

2.1. Output and Exports

(1) Value added

China's high-tech industry plays an important role in manufacturing and the total economy. In 2001, value added in China's high-tech industry was 309.5 billion yuan. Between 1998 and 2001, the high-tech industries' share in manufacturing GDP increased from 11.9 to 14.1 per cent. The share in total GDP increased from 2.3 to 3.2 per cent in the same period (see Table 1).

The electronic and telecommunications equipment industry is the largest industry within the high-tech sector. Its value added share was 5.8 per cent of manufacturing output in 1998 and has increased since. The second largest industry is medical and pharmaceutical products.

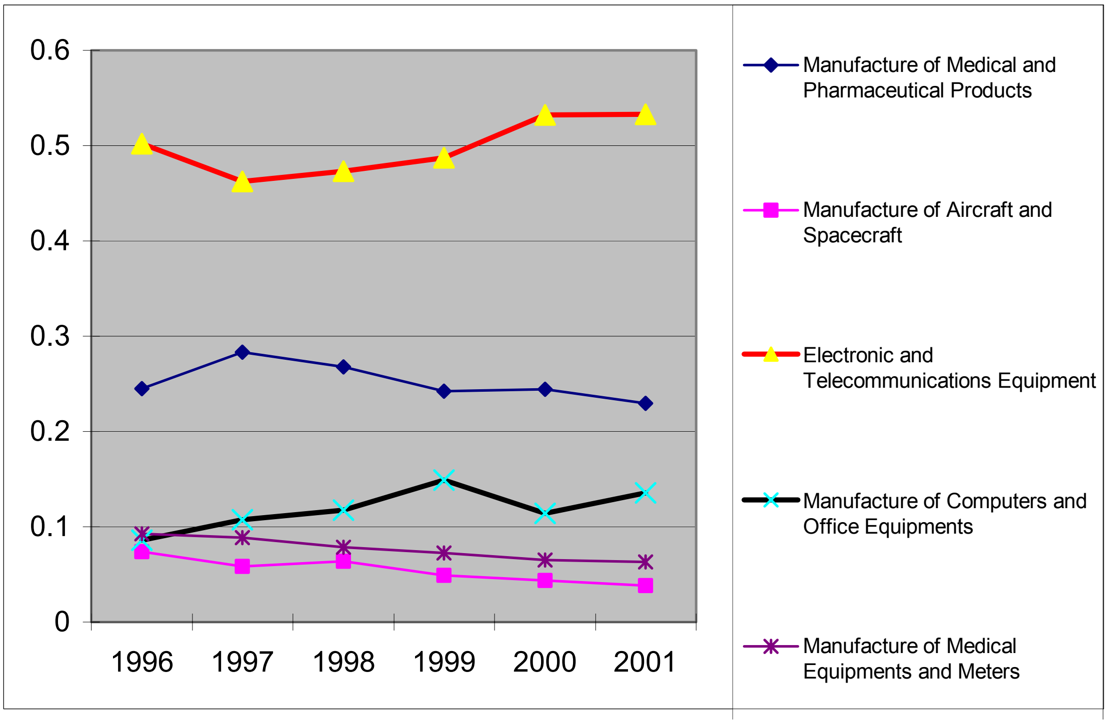
Figure 1 shows changes in the individual industries' shares within high-tech industry, between 1996 and 2001. The electronic and telecommunications equipment industry and computers and office equipment showed a modest increase, while the other industries' shares decreased slightly.

Table 1
Value Added Shares of High-Tech Manufacturing Sectors as Percentage of Total Manufacturing GDP and Total Economy GDP

Industry	1998	1999	2000	2001
Medical and pharmaceutical products	2.9	3.1	3.3	3.3
Aircraft and spacecraft	0.6	0.6	0.5	0.6
Electronic and telecommunications equipment	5.8	6.8	7.6	7.4
Computers and office equipment	1.8	1.5	1.9	2.0
Medical equipment and meters	0.9	0.8	0.9	0.9
Share of high-tech industries in total manufacturing	11.9	12.7	14.2	14.1
Share of high-tech industries in the total economy	2.3	2.6	3.1	3.2

Note: the value added of total manufacturing equals value-added of total industry minus value added of mining and quarrying, production and supply of electricity, water and gas, and construction.
Source: high-tech industries from unpublished data of NSB; value added in total manufacturing and the total economy from China Statistical Yearbook, issues 1999-2002. Sum of high tech sector shares differs marginally from total high tech share due to rounding.

Figure 1
Industry Shares within the High-Tech Sector



Sources: see Table 1.

(2) Growth of Value Added

Between 1999 and 2001, the average growth rate of value added in high-tech industries was 20.5 % per year. This is 1.5 times the growth rate of manufacturing (13.9%) and 2.7 times the total economy growth rate (7.5%). The growth rate of the manufacture of computers and office equipment wass higher than the average growth rate of high-tech industry.

Between high-tech industries, growth rates vary substantially. There are large fluctuations in both manufacture of computers and office equipment industry and the of aircraft and spacecraft industry, while other industries show little fluctuation (see Figure 2 below).

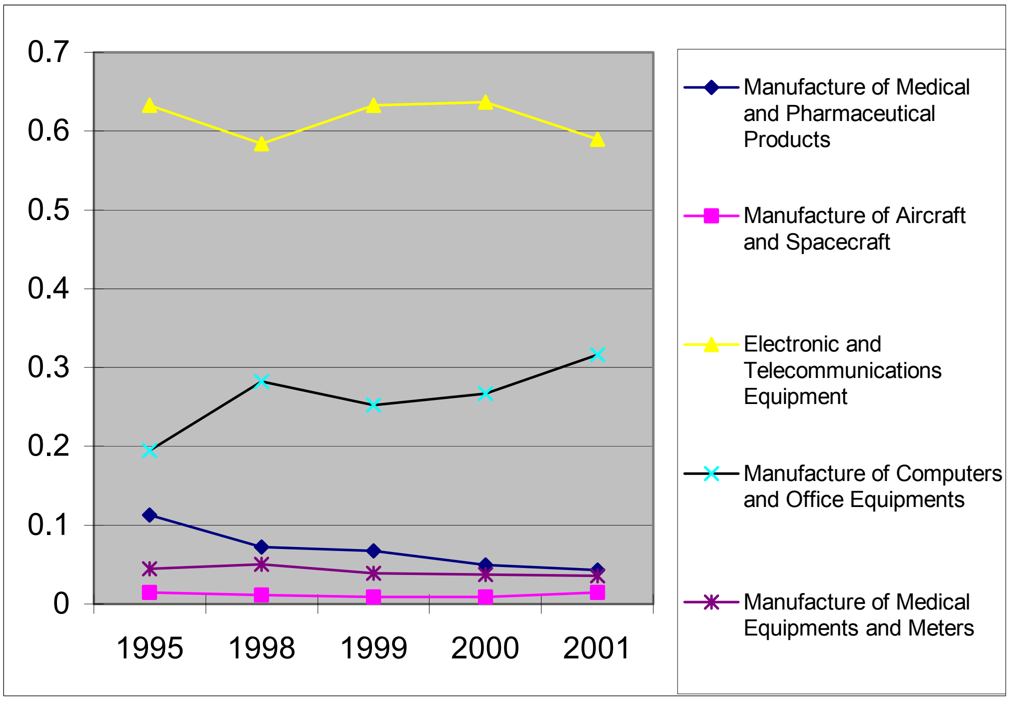
Table 2

Growth Rate of Value Added, 1999-2001

Total high-tech	20.5
Manufacture of Medical and Pharmaceutical Products	17.6
Manufacture of Aircraft and Spacecraft	15.1
Electronic and Telecommunications Equipment	19.7
Manufacture of Computers and Office Equipment	34.0
Manufacture of Medical Equipment and Meters	17.9
Manufacturing	13.9
GDP	7.5

Sources: value added in high-tech industries at constant 1996 prices see Annex table A.2; value added in total manufacturing and the total economy from *China Statistical Yearbook* (1999-2002).

Figure 2
Growth Rates of High-Tech Industries



Sources: same as Table 2

(3) Exports
China's high-tech industry has a much higher share in exports than in GDP. As can be seen from Table 3, the share of high-tech industries in total Chinese exports increased from 9 to 19 per cent from 1995 to 2001, compared to a value added share which increased from 2.3 to 3.2 per cent (table 1). The growth rate of high-tech industry exports is twice that of total exports. Especially exports of aircraft and spacecraft and computers and office equipment have experienced rapid growth during the period 1995-2001.

Table 3
High-Tech Industry Exports, 1995-2001
(100 million yuan, at 1995 prices)

Industry	1995	1998	1999	2000	2001	Growth rate (1999-2001)
Total high-tech exports	1125	3397	5012	6523	8179	27.8
Manufacture of Medical and Pharmaceutical Products	127	245	339	323	350	1.8
Manufacture of Aircraft and Spacecraft	16	38	46	60	122	66.9
Electronic and Telecommunications Equipment	712	1983	3172	4155	4825	23.6
Manufacture of Computers and Office Equipment	219	960	1263	1741	2588	43.2
Manufacture of Medical Equipment and Meters	50	171	193	245	294	23.5
Total export	12452	25336	33566	39731	42079	12.1
Ratio (high-tech/ total export)	0.09	0.13	0.15	0.16	0.19	

Sources: Exports of high-tech industries from unpublished data of NSB; total exports from *China Statistical Yearbook* (2002). Current data deflated by export price index from unpublished data base of NSB, see Annex table A.6.

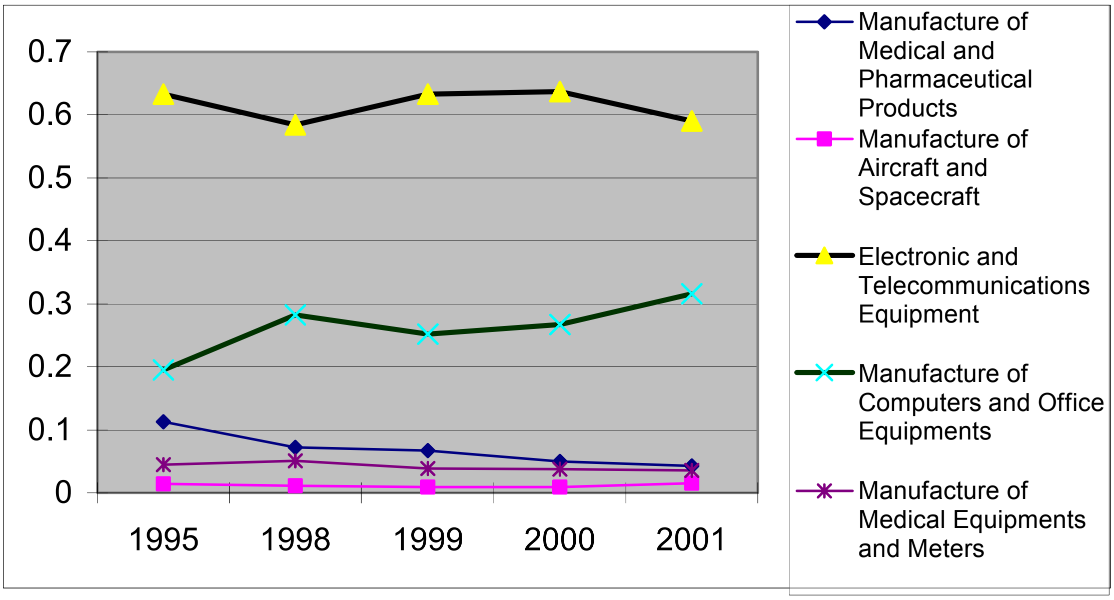
The share of high-tech commodity exports in total commodity exports increased from 4 per cent to 15 per cent between 1991 and 2000, while their share in total industrial commodity exports increased from 5.2 per cent to 17 per cent. Comparing these figures in table 4 with the total export shares in table 3, which increase from 9 per cent to 19 per cent, we conclude that the export shares of high-tech industry in services are higher than those in commodity exports. Within the high-tech sector, the export share of computers and office equipment increased rapidly during 1995-2001, while the shares of other sectors were stable or declined (see Figure 3).

Table 4
The Share of High-Tech Exports in Total Commodity Exports , 1991-2000 (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
% of total industrial exports	5.2	5.9	6.2	6.3	7.9	9.8	10.3	12.4	14.1	16.6
% total exports	4	4.7	5.1	5.2	6.8	8.4	8.9	11	12.7	14.9

Sources: MST (2000), *Research Report on China's High-tech Industries*, p. 85

Figure 3
Shares of High-Tech Industries in Total High-Tech Exports



Sources: Export of high-tech industries is obtained from unpublished data of NSB.

2.2. Efficiency

(1) Labour Productivity
Table 5 shows that labour productivity growth in the high-tech sector is extremely rapid. The average rate of productivity growth between 1996 and 2001 is no less than 24.6 per cent. Average labour productivity in the high-tech industries is substantially higher than that in total manufacturing. In 1998 high tech labour productivity is 57 per cent higher than in total manufacturing. In 2001 it is 65 percent higher. Szirmai et al. (2001, 2002) have shown that official statistics for the total manufacturing sector substantially overstate output and productivity growth in the 1990s. It is likely that similar biases exist for the high-tech sector. No adjustments to the published data have been made here, as we are more interested in the comparison of the high-tech sector and total manufacturing.

There are large differences between high-tech industries. Computers and office equipment enjoys the highest productivity, about twice as high as the average for the whole high-tech sector.The aircraft and spacecraft industry and the medical equipment and meters industry have lower labour productivity. Productivity in these sectors is lower than the average for total manufacturing.

Table 5
Labour Productivity Levels, 1996-2001
(10,000 yuan per capita, constant 1996 yuan)

	1996	1997	1998	1999	2000	2001	Growth Rate, 1996-2001
Total high-tech	2.76	3.59	4.75	5.87	7.37	8.21	24.6
Manufacture of Medical and Pharmaceutical Products	3.03	3.57	4.37	5.53	6.64	7.40	19.7
Manufacture of Aircraft and Spacecraft	0.99	1.83	1.82	2.00	2.42	3.14	29.0
Electronic and Telecommunications Equipment	3.32	4.26	5.50	7.23	8.83	9.69	24.1
Manufacture of Computers and Office Equipment	9.46	10.63	12.94	12.36	16.33	15.48	11.3
Manufacture of Medical Equipment and Meters	1.49	1.68	2.59	3.06	3.85	4.31	24.6
Total manufacturing	…	…	3.03	3.59	4.35	4.98	
Total economy	0.6	0.6	0.6	0.6	0.6	0.7	3.3

Sources: Value added per worker in high-tech industries is obtained from unpublished data of NSB; value added per worker in manufacturing and the total economy is obtained from *China Statistical Yearbook, 2002*. See Annex table A2 for value added in high-tech industries and Annex table A.4 for labour input in high-tech industries.

(2) The value added-output ratio

The ratio between value added and output is an indicator for productive efficiency, when an economy is less developed.[2] The data from Table 6 show the value added output ratios in the high-tech sector do not differ much from those in total manufacturing. There are three industries - medical and pharmaceutical products, medical equipment and meters, aircraft and spacecraft - in which the ratio is higher than in total manufacturing. In the two other industries it is lower.

Table 6
Ratio between Value Added and Output

Industry	1995	1996	1997	1998	1999	2000	2001
Total high-tech	0.26	0.26	0.26	0.25	0.26	0.27	0.25
Manufacture of Medical and Pharmaceutical Products	0.28	0.31	0.33	0.32	0.34	0.36	0.35
Manufacture of Aircraft and Spacecraft	0.30	0.26	0.31	0.27	0.28	0.27	0.26
Electronic and Telecommunications Equipment	0.25	0.24	0.23	0.23	0.24	0.25	0.24
Manufacture of Computers and Office Equipment	0.26	0.24	0.23	0.24	0.20	0.22	0.20
Manufacture of Medical Equipment and Meters	0.30	0.29	0.28	0.29	0.29	0.30	0.30
Manufacturing	…	…	…	0.26	0.26	0.26	0.26

Sources: data for high-tech industries is obtained from unpublished data of NSB; data for manufacturing is obtained from MST (2000), *Research Report on China's High-Tech Industries,* P17

[2] The value added output ratio is also influenced by the degree of specialisation and outsourcing.

The comparative data in table 7 suggest that there are large efficiency differences in high-tech industry between China and some developed economies, including South Korea. The low level of efficiency in manufacturing is consistent with the findings of Szirmai et al. (2002) for total manufacturing in China

Table 7.
Chinese Value Added Output Ratios in Comparative Perspective (%)

	USA 1993	Japan 1993	Germany 1993	UK 1992	Italy 1987	Korea 1993	China 2001
Manufacturing	36.1	37.1	37.1	32.2	35.8	28.4	26.4
Total high-tech industry	42.6	37.2	48.9	34	41.1	35.3	25.2
Manufacture of Medical and Pharmaceutical Products	32.6	41.7	42.7	28.9	40.3	…	35.4
Manufacture of Aircraft and Spacecraft	51.1	34.8	48	36.2	46.4	35.6	26.4
Electronic and Telecommunications Equipment	27.9	31.7	55.4	24	31.5	31.7	23.5
Manufacture of Computers and Office Equipment	56.4	61.8	49.7	48.7	43	44.5	19.6
Manufacturing excl. high-tech	35.1	37.1	36	31.9	35.4	27.2	…

Sources: Data for foreign countries is obtained MST (2000), *Research Report on China's High-Tech Industries*, P17; data for China is derived from unpublished data of NSB and *China Statistical Yearbook,2002*.

In sum, China's high-tech sector has experienced very rapid growth in recent years. Its contribution to Chinese export performance has increased substantially. Labour productivity in the high-tech industries is higher than the average for manufacturing, but the sector is still characterised by low value added-output ratios, indicating lower degrees of efficiency, even today.

3. Measuring the Stock of R&D Capital in High-Tech Industries

A standard procedure for analysing the relationship between R&D expenditures and productivity is to employ a Cobb-Douglas production function, using the stock of R&D capital as an input along with the conventional inputs such as capital and labour. R&D capital represents the stock of knowledge a firm or an industry possesses at a certain point of time. It is accumulated through the R&D efforts of a firm or an industry. Like physical capital it depreciates and becomes obsolete. The Perpetual Inventory Method (PIM) can be applied to construct R&D stocks as well physical capital stocks. This approach can be found in Verspagen (1997), Griliches (2000) and Mairesse (1984), Cuneo and Mairesse (1984), Jones (1995), Coe and Helpman (1995).

Following Griliches (2000) and Goto and Suzuki (1989), the change in the stock of R&D capital depends on the amount of R&D investment and the previous level of this stock. We represent the R&D stock as follows:

$$R_t = \sum_{i=1}^{n} \mu_i E_{t-i} + (1-\delta) R_{(t-1)}$$

where R_t is the R&D stock at time t, μ is the lag operator that connects past R&D expenditure E_{t-i} to the current increase in technological knowledge, and δ is the rate of obsolescence of R&D capital.

μ is some sort of distributed lag. As it is difficult to obtain the information required to specify the lag structure, we simply use the average lag θ. We assume that R&D expenditures in period t-θ constitute the increase in the R&D stock in period t. Thus, the equation above reduces to:

$$R_t = E_{t-\theta} + (1-\delta) R_{t-1}$$

We follow Coe and Helpman (1995), in assuming that the growth rate of E is the same as the growth rate of R. We also assuming a time lag θ of 1 year. Thus the initial amount of R&D capital, R_0, and the R&D capital at time t, R_t, can be obtained separately as follows:

$$R_0 = E_0/(g+\delta),$$
$$R_t = E_{t-1} + (1-\delta) R_{t-1}$$

Where g is the growth rate of E.

We estimate the stocks of R&D capital in China's high-tech industries, on the basis of the equations and assumptions above. First, following Coe and Helpman (1995), we calculate real R&D expenditures by deflating nominal expenditures by a R&D price index (PR).

PR is defined as

$$PR = 0.5 * P + 0.5 * W$$

where P is the implicit deflator for business sector output and W is an index of average business sector wages. This definition of PR implies that half of R&D expenditures are labour costs, which is broadly consistent with the available data on the composition of R&D expenditures. We chose the ex-factory price index in manufacturing to represent P. We used the consumer price index (CPI) to represent W.

We calculated g following Griliches (1980), where g is the average annual logarithmic growth of R&D expenditure over the period for which published R&D data were available. Following Verspagen (2000) and Griliches (1990), δ was assumed to be 15 per cent. This is the percentage commonly used in firm level studies (Griliches, 1990). Goto and Suzuki (1989) used the "life span" to estimate the rate of obsolescence of R&D capital. They found a rate of obsolescence in communications equipment and transportation equipment (including aircraft) of 14.5 per cent, very close to our assumed rate of 15 per cent.

Table 8 summarizes our estimates of R&D capital in 21 Chinese high-tech industries. The stock of R&D capital is large in Electronic and Telecommunications Equipment, accounting for over half of the total high-tech stock. The highest R&D intensities (R&D/labour and R&D capital ratios) are found in the Telecommunications sector, in particular in the sector producing Telecommunication Exchange Units. In terms of R&D intensity, computers come in the second place. In terms of the growth of R&D stocks, the Telecommunication Exchange Unit subsector shows the highest growth from 1996 to 2001, followed again by computers and office equipment. The average growth rate of R&D stock in high-tech industry is 20.6 per cent for 1996-2001, and it is less than 39 per cent, the average growth rate of R&D expenditure at the same time.

Table 8
R&D Capital in China's High-Tech Industry in 2001
(Constant 1996 prices)

Industry	R&D capital (10 million yuan)	R&D stock per worker (1000 yuan)	R&D stock/capital	Average growth rate 1996-2001
Total	30.628	0.077	0.009	20.6
Manufacture of Medical and Pharmaceutical Products	4.614	0.045	0.007	11.4
1.Chemical Pharmaceutical Products	3.281	0.052	0.008	10.0
2. Processing of Traditional Chinese Medicine	0.887	0.029	0.005	14.2
3. Biology Products	0.423	0.061	0.005	19.0
Manufacture of Aircraft and Spacecraft	5.445	0.130	0.024	6.7
1.Manufacture and Repair of Aircraft	4.458	0.122	0.020	7.0
2. Manufacture of Spacecraft	0.988	0.188	0.286	6.2
Electronic and Telecommunications Equipment	16.165	0.091	0.009	34.2
1. Telecommunication Equipment	8.899	0.260	0.020	43.3
Telecommunication Transmission Unit	1.196	0.177	0.020	32.2
Telecommunication Exchange Unit	6.621	0.959	0.049	54.1
Telecommunication Terminal Unit	0.387	0.036	0.002	17.7
2. Radar and Peripheral Equipment	0.398	0.081	0.022	3.7
3. Broadcast and Television Equipment	0.063	0.027	0.011	6.0
4.Electronic Apparatus	1.794	0.068	0.003	19.7
Electronic Vacuum Apparatus	1.208	0.112	0.004	22.9
Semiconductor Separated Parts	0.234	0.026	0.002	13.1
Integrated Circuits	0.352	0.055	0.002	16.1
5.Electronic Components	1.583	0.023	0.004	28.9
6. Household Audiovisual Equipment	3.076	0.101	0.011	45.0
7. Other Electronic Equipment	0.352	0.032	0.006	130.7
Manufacture of Computers and Office Equipment	2.904	0.099	0.011	50.3
1. Computers	2.048	0.247	0.039	52.8
2.Peripheral Equipment of Computer	0.803	0.048	0.004	54.3
3. Office Equipment	0.053	0.012	0.001	19.6
Manufacture of Medical Equipment and Meters	1.500	0.032	0.009	11.4
1.Medical Equipment and Instruments	0.249	0.020	0.006	19.7
2.Instruments and Meters	1.251	0.036	0.010	10.2

Sources: National Bureau of Statistics of China (NBS), 1999-2002, China Statistical Yearbook (1999-2002), China's Statistics Press; China's Ministry of Science and Technology, 2002, forthcoming.
See Annex table A.7 for R&D stocks, Annex table A5 for labour input, and Annex Table A.12 for capital stocks.

4. Measuring the Physical Capital Stock in High-Tech Industries

4.1. A Brief Overview of Approaches to the Measurement of Capital

Till now, China's official statistical authorities haven't made standard capital estimates according to the PIM. There is little detailed information on annual capital investment and prices. The National Statistical Bureau (NSB) only publishes data on "the original value of fixed assets" and "net value of fixed assets" as indicators of the current capital stock at aggregate level. The method used to calculate the original value of fixed assets is to add the value of the investment in fixed assets in the current year – which consists of a mix of fixed structures (factories, offices and dwellings), equipment and machinery - to the value of the existing stock of fixed assets at historical or acquisition prices (Statistics Yearbook, NSB). The net value of fixed assets is calculated by deducting the cumulated depreciation from the "original value of fixed assets ". No one knows how the depreciation rate is calculated.

According to OECD (2001), the basic requirements to apply the PIM to estimate the Gross Capital Stock are:

- An initial benchmark estimate of the capital stock.
- Statistics on gross fixed capital formation extending back to the benchmark, or, if no benchmark is available, back over the life of the longest-lived asset.
- Asset price indices.
- Information on the average service lives of different assets.
- Information on how assets are retired around the average service life.

Two main difficulties have to be resolved when PIM is to be used for China. One difficulty is to obtain information about the length of the time series of gross fixed capital formation available at both current and constant prices in order to explore the feasibility of the compiling estimates of stocks of the fixed assets using PIM. Another difficulty is to determine what are the most appropriate depreciation rates at which the efficiency (hence the value) of the assets can be written down in order to calculate capital consumption. Studies which have tried to estimate the Chinese capital stock using PIM, include Chen, Kuen et al.(1998), Li et al.(1993), Ren and Huang (1998) and Wu and Xu.(2002).

(1) The study by Chen, Kuen et al.(1988) is a pioneering attempt to construct gross capital stock and net capital stock series for the state industrial sectors from 1952 to 1985. Their outstanding contribution is to decompose the investment flows into four types of assets, namely, "equipment", "industrial construction", "housing", and "other", then to construct four prices indices to deflate each type of the assets. But the work didn't really follow the PIM, for it accepted the official depreciation rates of which no one has explained how they were calculated. The initial benchmark estimate of the capital stock in yearbook is also different from PIM. Also Chen et al. did not allow for scrapping.
(2) The study by Ren and Huang (2000) has explained the PIM very well. It has constructed structure and equipment capital stock series at in China's manufacturing sector from 1980-1995 by three efficiency decrease patterns, namely, the "one-hoss shay pattern", the "straight-line pattern" and the "geometric declining balance pattern". But there is no information on the discount rate. If the age-efficiency profiles are applied, the discount rate has to be used to estimate age-price profiles and depreciation. Only under the geometric form, does replacement requirement equal the depreciation rate. For the two other patterns, they are not

the same. This may result in confusion between the concepts of replacement and depreciation, when applying straight-line pattern to calculate capital stock.

The estimates for the early years had to rely on on a great many data assumptions. For example, the use of GDP series from Maddison (1998) and investment rates from Feuerwerker's study to estimate historical investment data, may affect the results. However, because the weight of earlier years in PIM is much less, errors will not have a major influence on the final stock estimates. There is nothing wrong with making data assumptions. We will rely on assumptions in our estimates below, as well.

(3) The study by Harry X. Wu and Xianchun Xu (2002) has estimated the capital stock in Chinese industry by PIM using hitherto unpublished data on investment. It classified the industry capital stock into two classes: non-residential structures and equipment, deducting the residential structures from the total capital stock to keep input consistent with production. Wu and Xu constructed indices for two kinds of capital assets, followed the geometric depreciation function to estimate depreciation. To obtain the depreciation rate, the paper directly adopted the BEA estimates of the declining balance rate for a list of major types of industrial equipment and structure to reflect changes in economic efficiency of different types of fixed assets in China's industry. We think these may be a source of bias, because depreciation rates from the USA may not be applicable to China.

In the following section we will attempt to estimate capital stocks for the high tech sectors. We will use proportions of structures and equipment from Ren and Huang (2000) to break down our high-tech capital stock benchmark estimate. We subsequently will apply the sectoral depreciation rates from Wu and Xu (2002) to calculate depreciation in high-tech industries.

4.2. Measuring Capital Depreciation in Hi-Tech Industries

(1) Objectives

When we consider explanations of economic development in terms of the different contributions of the various factors of production, we should measure the "equivalent capital services, production factor values at constant base period prices" (Ward, 1976). The quantity of capital inputs in production are measured by capital services, and their prices by the user costs or rental values of capital,. So our objective should be to calculate capital services at user cost.

In the absence of directly observable flows of capital services, these are approximated as proportionate to the productive capital stock. The productive capital stock is the stock of a particular, homogenous, asset expressed in "efficiency" capital units. Subtracting the depreciation from the gross capital stock gives the net stock of productive capital. In practice, the net capital stock tends to be used as capital input in the production function (OECD, 2001).

So, in order to find a proxy for capital services, we need to obtain the net capital stock through depreciation. Depreciation is the difference between successive real market values of an asset values. According to OECD (1996), if the price is stable, the depreciation is simply the change in the market value of an asset from one accounting period to the next.

(2) Method

The method consists of three steps. As a first step we estimate the original value of fixed assets in 1996 by using incremental capital-value added ratios (ICVARs). Next, we construct time series of net investment by sector and type of asset for the period 1996-2001. Finally, we construct net capital stocks using depreciation rates..

A. The Original Value of Fixed Assets
Time series of investment are too short to construct an initial benchmark estimate according to PIM. For lack of an initial benchmark estimate of the capital stock, we therefore use a short-cut method, following Timmer (1999), calculating the benchmark stock on the basis of incremental capital-output ratios. According to economic theory, if the economy is at full capacity, the incremental capital–output ratio will approximate the average capital output ratio. Considering the rapid development of high-tech industry in recent years (see section 2), we assume that the high-tech sector is operating close to full capacity.

For our capital-output ratio for 1996, we use the average of five ICVARs for the years 1997-2001**.** A one-year ICVAR is not preferred as it is too sensitive to annual fluctuations.

There is very large variation in the capital-output ratios across the 21 high-tech industries. To avoid too large variation, and to keep the total assets equal to the sum of individual assets, we calculate the original assets in 1996 using an aggregate capital-output ratio of 1.23 for all industries **(**see Annex Table A.8**)**. We apply the ratio 3.2 to 1 between fixed structures and equipment for total manufacturing from Ren and Huang (2000) to divide the capital stock in 1996 into two classes for all high-tech industries.

B. Investment in High-Tech Industries during 1997-2001
Because lack of breakdown in the investment data for the high-tech sector, we assume that the ratio between investment in structures and investment in equipment in high-tech industries is equal to the ratio for the total economy, which is available from the China Statistical Yearbook (1999-2002). We separate the net investment (i.e. investment minus scrapping) in high-tech industries into net investment in structures and net investment in equipment by using the ratio for the total economy. Then we deflate the investment series at current prices into series at 1996 constant prices, using the price index for structures and the price index for equipment **(**see Annex Table A. 6**)**

C. Net Capital Stock
Applying the standard PIM, we get net capital stock data for fixed structures and equipment in high-tech industries during 1996-2001. The standard PIM equation is:

$$K_t=(1-\delta)\ K_{t-1}+NI$$

Where K_t denotes the capital net stock, δ denotes the depreciation rate, NI denotes the net investment, namely the investment minus scrapping. We use the sectoral depreciation rates (1988-1998) from the paper *Measuring the Capital Stock in Chinese Industries* by Wu and Xu (2002) to calculate depreciation, i.e capital consumption in high-tech industries. For medical and pharmaceutical products, we use the depreciation rate of the medical products sector (MED) directly. For electronic and telecommunications equipment, we use the average of the depreciation rates of the telecommunications sector (TEL) and other manufacturing (OTH). For other industries, we use the OTH depreciation rate. Applying the equation above, we obtain the net capital stock for high-tech industries (see Annex Table A.12)

5. The Impact of R&D on Output and Productivity

5.1. The Model

A common and popular approach to examine the relationship between R&D and productivity is to treat R&D capital as another type of capital, which is to be added to the list of aggregate production function variables:

$$Y= A\, e^{\lambda t}K^{\alpha}\, L_i^{\beta}R^{\gamma} \qquad (1)$$

where Y is output, K and L represent physical capital input and labour input respectively, R is R&D capital input. A is a constant, λ is the rate of disembodied "external" technical change, α is the elasticity of output with respect to capital input, β is the elasticity of output with respect to labour input, γ is the elasticity of output with respect to R&D capital. It is easy to transfer the equation above as follows:

$$\text{Log } Y= \text{Log } A +\lambda t +\alpha \text{Log } K + \beta \text{Log } L + \gamma \text{Log } R \quad (2)$$

Equation (2) was estimated by Griliches (1980, 1986, 2000), and by Griliches and Mairesse (1984) using time series data for individual U.S. companies, and by Griliches (1973) and others using industry level data. The estimated elasticity of output with respect to R&D capital tends to lie between 0.05 and 0.2.

Differentiating equation (2) with respect to time, (2) can be written as:

$$d\log(Y)=\lambda+\alpha d\log(K)+\beta d\log(L)+\rho(E/Y)+\mu \quad (3)$$

where $d\log(X)= (dX/ dt)/X$; E denotes the net R&D investment. Most of the previous studies have simply used R&D expenditure instead of R&D stock, so that they can avoid the difficult task of measuring the stock of R&D capital .The parameter ρ can be interpreted as the rate of return to investment in R&D capital. Thus the productivity growth is directly related to some measure of R&D intensity.

Equation (3) has been estimated by Griliches (1986), Clark and Griliches (1984), Link(1981a, 1981b), and Mansfield (1965), among others, using firm level data, and by Griliches and Lichtenberg(1984), Scherer (1982, 1984), Goto et al. (1989) and others using industry aggregates. The estimated rate of return to R&D lies mainly between 0.2 and 0.5, with some recent estimates falling in the lower part of this range.

5.2. Estimation Results

(1) *The relationship between R&D and labour productivity in high-tech industries*

To capture the relationship between R&D and labour productivity, we separate the high-tech industries into two subsectors: the electronic industries and the non-electronic industries.

To focus on the relationship between R&D stock and labour productivity, we build our model based on equation (2). We rewrite the equation (2) in terms of labour productivity as:

$$yl= a+\lambda t +\alpha(kl)+\eta l + \gamma r \qquad (4)$$

where $yl = \log(Y/L)$, $kl = \log(K/L)$, $l = \log(L)$, $r=\log(R\&D)$ and $\eta=\alpha+\beta-1$, which denotes the scale parameter.

The basic characters of the data used in our models are described as Table 9.

Table 9
Descriptive Statistics of the Variables Used

Descriptive statistics	Mean	S.D.	Skew	Kurt	Mini	Maxi	NO
LnY	4.06	1.12	-0.39	-0.70	1.39	6.03	126
LnK	4.10	1.14	-0.65	0.41	-0.15	6.04	126
Ln(Y/L)	1.58	0.81	-0.01	-0.49	-0.36	3.56	126
Ln(K/L)	1.62	0.80	-0.64	2.93	-2.18	3.52	126
LnL	2.48	0.93	0.50	-0.81	0.76	4.31	126
LnR&D	-0.93	1.33	-0.38	0.24	-5.22	1.87	126

Note: S.D.= Standard Deviation; Skew = Skewness; Kurt = Excess Kurtosis; Max = Maximum. Min = Minimum. NO = Number of Observations. Unit of measurement 10 mill. yuan.

Estimation has been done in a panel data framework. Four models have been estimated: the "between" model, exploiting the between dimension of the data (differences between sectors); the "fixed effects (within)" model, exploiting the within dimension of the data (differences within sectors); the "OLS" model, exploiting both dimensions (within and between); the random effects (FGLS) model, combining the information from the between and within dimension in a more efficient way.

The between estimators are determined as the OLS estimator in a regression of individual averages of y on individual average of the explanatory variables (and a constant). The fixed effects (within) estimators are determined as the OLS estimators in a regression in deviations from individual means. The "OLS" estimators are determined as OLS in the original model. The random effects model combines the information from the between and within dimension, its estimators are determined by GLS.

The estimation result for the total high sector is shown in Table 10. The Hausman test favoured a sector specific random effect model against the choice of a fixed effect specification. All four estimators in Table 10 are consistent; the "GLS" estimators are the most efficient ones. We can see clearly that the elasticity of output with respect to capital input for the total high-tech sector is 0.39. A negative value for the returns to scale η suggests decreasing return to scale, this is always the case in empirical studies based on production functions. The elasticity of output with respect to R&D capital is 0.11. The elasticity of productivity with respect to labour input is about 0.40 (β=1-0.386-0.208).

Table 10
Estimation Results in High-Tech Industries
(t values in parentheses)

Independent variable yl Coefficient	a	(kl)	l	r	t	R^2	s^2
The "GLS" Model	1.1210 (3.51)	0.3860 (6.20)	-0.2080 (-2.33)	0.1069 (1.88)	0.1300 (5.85)	0.6850	0.0772
The "OLS" Model	0.47 (0.99)	0.72 (6.64)	-0.13 (-1.18)	0.06 (0.71)	0.09 (4.24)	0.69	0.21
The "between" model	0	0.8515 (6.64)	-0.0870 (-0.654)	0.0280 (0.284)	0.1264 (0.888)	0.7531	0.1562
The "within" model		0.1431 (1.20)	-0.2749 (-1.21)	0.0709 (1.05)	0.1731 (7.10)	0.7593	0.0539

Number of observations =126; Number of sectors =21, time series: 1996 – 2001, balanced panel.

The results are nearly the same in the electronic industries and the non-electronic industries. The Hausman test favoured a sector specific random effect model against the choice of a fixed effect specification. All four estimators in Table 11 and Table 12 are consistent; the "GLS" estimators are the most efficient ones. In Electronic industries, the elasticity of output with respect to capital input is 0.26, the elasticity of output with respect to labour input is not significant, and the elasticity of output with respect to R&D capital is 0.10. In Non-Electronic industries, the elasticity of output with respect to capital input is 0.52, with respect to labour input 0.72 and with respect to R&D 0.13. All elasticities are higher than for the total high tech sector.

Table 11
Estimation Results in Electronic Industries
(t values in parentheses)

Independent variable yl Coefficient	a	(kl)	l	r	t	R^2	s^2
The "OLS" Model	0.6578 (0.973)	0.4150 (2.51)	-0.0191 (0.14)	0.0727 (1.10)	0.0910 (1.8)	0.6577	0.3190
The "GLS" Model	0.9675 (1.93)	0.2590 (2.39)	-0.51 (0.14)	0.1001 (1.49)	0.1179 (2.9)	0.8076	0.1923
The "between" model	0	1.029 (1.06)	0.5590 (0.585)	-0.4050 (-0.526)	-0.6483 (-0.439)	0. 7362	0.2472
The "within" model		0.0882 (0.870)	0.24 (1.36)	0.0142 (0.239)	0.1825 (5.46)	0.8762	0.1836

Number of observations =36, Number of sectors =6, time series: 1996 – 2001, balanced panel

Table 12
Estimation Results in Non-Electronic Industries
(t values in parentheses)

Independent variable yl Coefficient	a	(kl)	l	r	t	R^2	s^2
The "OLS" Model	0. 4361 (0.836)	0.8367 (6.05)	-0.1806 (-1.5)	0.0865 (0.983)	0.1010 (6.05)	0.7434	0.2182
The "GLS" Model	0.9675 (1.93)	0.5213 (6.75)	-0.2457 (-2.21)	0.1291 (1.64)	0.1267 (4.61)	0.6717	0.1020
The "between" model	0	0.9887 (6.97)	-0.1502 (-0.975)	0.0631 (0.56)	0.1324 (0.876)	0.8414	0.1457
The "within" model		0.1690 (0.952)	-0.3664 (-1.21)	0.1381 (0.877)	0.1624 (4.75)	0.7428	0.0621

Number of observations = 90, Number of sectors =15, time series: 1996 – 2001, balanced panel

In sum, in China's high-tech industries, a negative value for the returns to scale η suggests decreasing return to scale. This is similar to the results of other empirical studies based on production functions. The elasticity of output with respect to R&D capital of 0.10 shows that the contribution of R&D capital growth to labour productivity growth in China's high-tech industries lies in range suggested by prior empirical research.

(2) Spillovers in high-tech industries

It is not easy to estimate the contribution of R&D to productivity growth. One reason is our inability to estimate correctly the magnitude of R&D spillovers from one firm, industry, or country to another. Much of the new knowledge created by R&D tends to seep out beyond the borders of the sector where the research was done, leaving few traces as to where it leaked and whence it came. There have been several interesting attempts to capture the impact of such spillovers and model their spread (Bresnahan, 1986; Bernstein and Nadiri, 1986; Scherer, 1982; Terleckyj, 1974; Coe, Helpman, 1995; Verspagen, 2000 and others).

To estimate the spillovers, an input-output analysis of transaction flows is normally used. Because we only have limited data for this study, we simply use the R&D stock of one industry as an input into other industry to estimate the spillovers from one industry to another. We find there is some evidence of spillovers from electronic to non-electronic industries. But, measured in this way, there are no spillovers between other industries, or from non-electronic to electronic industries. The model we used is based on equation (5),

$$y = a + \alpha k + \eta l + \gamma r + \zeta (re) \quad (5)$$

where "re" is the log of R&D stock in electronic industries.

Estimation has again been done in the panel data framework. The Hausman test favoured a sector specific random effect model against the choice of a fixed effect specification. The random effects model is estimated by GLS (see Table 13). From Table 13, the direct elasticity of output in non-electronic industries with respect to own R&D capital is 0.1087, the elasticity of labour productivity with respect to electronic industry's R&D capital is 0.4293. It is larger than the direct elasticity 0.1084. We may conclude there is spillover influence from electronic industries R&D to non-electronic industries labour productivity in China's high-tech industries.

Table 13

R&D Spillovers from the Electronic Industry to Non-electronic Industries

Independent variable yl Coefficient	a	(kl)	l	r	(re)	R^2	s^2
The "OLS" Model	0.4586 (0.957)	0.7161 (6.65)	-0.1302 (-1.18)	0.0634 (0.714)	0.0382 (4.21)	0.6902	0.2135
The "GLS" Model	1.101 (3.43)	0.3870 (6.20)	-0.2114 (-2.37)	0.1087 (1.91)	0.4293 (5.8)	0.6839	0.0775
The "between" model	0	0.8515 (6.64)	-0.0870 (-0.654)	0.0281 (0.284)	0.3969 (0.888)	0.7531	0.1563
The "within" model		0.1430 (1.22)	-0.2902 (-1.29)	0.0742 (1.06)	0.5717 (6.86)	0.7579	0.0543

Number of observations = 90, Number of individuals =15, time series: 1996 – 2001, balanced panel

(3) Other technological input and labour productivity growth

Finally, we would like to compare the relationship between labour productivity growth and other technological inputs, with that between labour productivity growth and the direct R&D stock. We include other technological inputs as one of the inputs into production function (see Annex Table A. 5). Other technological inputs include technical renovation expenditure, expenditure on imports of technology, expenditure on technology absorption and expenditure on purchase of domestic technology. The model is based on equation (4) , adding other technological inputs as one of the inputs.

$$yl = a + \lambda t + \alpha(kl) + \eta l + \gamma r + \xi(ro) \quad (6)$$

where "ro" is the log of other technological input.

We list three kinds of models in Table 14. The Hausman test favoured a random effect model against a fixed effect model. GLS estimators are most efficient. From the "GLS" model, we can see the elasticity of output with respect to own R&D capital is 0.1064, while the elasticity of output with respect to other technological inputs is only 0.0087. The coefficient for R&D is similar to that in the model without "ro" factor. The coefficient of "ro" is not significant. This implies that there is no significant relationship between other technological inputs and labour productivity in China's high-tech industry, while there is a significant relationship with the the direct R&D stock.

Table 14
Other Technological Inputs and Productivity Growth
Estimation Result (t value in parentheses)

Independent variable yl Coefficient	a	t	α(kl)	η(l)	γ(r)	ξ(or)	R^2	s^2
The "OLS" Model	0.2226	0.0913	0.7319	-0.1051	- 0.0819	-0.0316	0.6919	0.2141
	(0.385)	(4.04)	(6.44)	(-0.924)	(0.869)	(-0.735)		
The "GLS" Model	1.1987	0.1289	0.3855	-0.2187	0.1064	0.0087	0.6845	0.28
	(2.65)	(5.57)	(5.98)	(-2.23)	(1.87)	(0.277)		
The "Within" Model		0.1696	0.1389	-0.3030	0.0791	0.0131	0.7598	0.0543
		(7.45)	(1.2)	(-1.41)	(1.20)	(0.39)		

Number of observations =126; Number of sectors =21, time series: 1996 – 2001, balanced panel.

6. Avenues for Further Research and Conclusions

6.1. Weaknesses and Avenues for Further Research

This paper represents a preliminary attempt to chart a new and important field, namely that of the impact of R&D in high-tech industries. It should be seen as a first step. Further research is required in this area. Here we list some of the problems that will have to be tackled in future research.

(1) Data problems.
Capital Stock Estimates
We were forced to make a large number of assumptions in order to put together estimates the capital stock and R&D stock. Assumptions include
- The use of the ratio between investment in structures and equipment in the total economy as a proxy for the ratio in various high-tech industries;
- The assumption that the obsolete value of fixed assets is zero;
- The assumption of a lag period of 1 year in estimating the R&D stock from R&D expenditure data.

- The use of a single incremental capital-output ratio for all high-tech sectors, to estimate the benchmark capital stock

These assumptions could all affect our estimates. We have made use of results of recent studies of the Chinese capital stock to make our own estimates for the high-tech sector. But the assumptions in these studies may not be applicable to the high-tech sector and may also give rise to errors.

So far we haven't done any work on human capital; just using the numbers of persons employed as input. It is well known that human capital plays a very crucial role in new growth theory.

The time series for the high-tech sector are too short to construct capital stocks according to the PIM and impose limits on our analysis of long run trends in this sector.

Coverage

In assessing the importance of the high-tech sector in total manufacturing, issues of coverage need to receive far more attention. It is by now well known that different time series from the China Statistical Yearbook have different levels of coverage, without this being explicitly mentioned in the published sources (Szirmai et al. 2001). The coverage of the high-tech sector needs to be analysed in more detail, in order to be able to make reliable comparisons with the total manufacturing sector. What subset of the sum total of manufacturing establishments provides the basis for the time series of the high- tech sector.

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(2) Other problems.

It is difficult to estimate the contribution of R&D to productivity. As Griliches (1995) has mentioned, it is usually underestimated in empirical research. In fact, it is very difficult to estimate the effects of improvements in technology on output growth. Technology interacts with inputs of physical and human capital. It is difficult to estimate the separate contributions of R&D and capital.

Further research needs to be done, both in terms of data and in terms of analysis. When considering the spillovers, these should be calculated more exactly using input-output procedures. Our approach is only a highly simplified first step. Meanwhile, it is also necessary to take other spillovers into consideration, especially through imports of capital and technology in foreign trade. There may also be important spillovers at firms, where others profit from the R&D investments of a given firm.

6.2. Conclusions

The study in this paper is based on detailed data on China's high-tech manufacturing industries, which have only recently come available. China's high-tech sector has experienced very rapid growth in recent years. Between 1996 and 2001, the average growth rate of GDP is 20.5 per cent, and the average growth rate of labour productivity is no less 24.6 per cent. Among the inputs, the average growth rate of the capital stock is 15.8 per cent, the average growth rate of the R&D stock is 20.6 per cent, while labour input declined by 2.8 per year.

Using a Cobb-Douglas production function, combining capital and labour inputs with an R&D stock, we estimate that changes in labour input contribute significantly to output growth. The elasticity of output to labour input is 0.40. In the period studied, aggregate labour input is actually shrinking by 2.8 per cent per year, which implies that other things being equal its contribution to growth is negative. However, the growth of output in the period studied turns out to be very rapid, due to dramatic increases in labour productivity.

Our interpretation is that the shakeout of less productive labour, increases in labour quality and rapid increases in capital intensity contribute to productivity growth. Capital input contributes to output growth the same degree as changes in labour input. The elasticity of labour productivity growth to changes in capital intensity is 0.39.

We found a significant relationship between growth of the stock of R&D and labour productivity growth. The elasticity of labour productivity with respect to change in the R&D stock is about 0.10. It shows that the contribution of R&D capital growth to labour productivity growth in China's high-tech industries lies in range suggested by prior empirical research.

The empirical analysis points to the possible existence of spillovers from the electronic industry to non-electronic high-tech sectors. There are no other spillovers from the other high-tech industries. No significant relationships were found between other technological inputs and productivity growth.

Statistical Annex

1. Basic Data

Annex Table A. 1
R&D Expenditure of China's High-Tech Industries, 1995-2001
(10 million yuan)

Industry	1995	1996	1997	1998	1999	2000	2001
Total	178.47	309.58	420.15	564.50	675.58	1110.41	1570.11
Manufacture of Medical and Pharmaceutical Products	42.78	56.47	66.16	76.45	92.59	134.67	192.54
1.Chemical Pharmaceutical Products	32.70	42.09	49.50	58.03	61.98	88.36	118.38
2. Processing of Traditional Chinese Medicine	7.20	9.59	9.11	12.93	21.61	29.23	52.35
3. Biology Products	2.71	4.24	7.13	5.18	8.46	16.57	21.34
Manufacture of Aircraft and Spacecraft	65.07	96.81	82.67	70.48	86.80	137.93	165.22
1. Manufacture and Repair of Aircraft	52.67	90.28	72.54	55.18	57.82	119.25	145.10
2. Manufacture of Spacecraft	12.40	6.53	10.13	15.29	28.98	18.68	20.12
Electronic and Telecommunications Equipment	51.29	117.34	178.77	347.68	388.54	679.44	1053.86
1. Telecommunication Equipment	19.97	45.64	79.49	200.88	226.87	397.60	714.83
Telecommunication Transmission Unit	4.59	4.11	9.99	21.85	18.74	63.90	60.33
Telecommunication Exchange Unit	10.21	29.44	53.62	165.71	191.72	281.56	511.71
Telecommunication Terminal Unit	2.61	4.60	6.29	4.74	11.12	11.69	109.61
2. Radar and Peripheral Equipment	5.62	3.89	7.87	5.40	7.76	7.00	17.01
3.Broadcast and Television Equipment	0.81	1.43	1.00	0.28	0.59	2.04	2.28
4. Electronic Apparatus	11.74	24.09	16.49	23.49	21.88	85.82	65.29
Electronic Vacuum Apparatus	6.76	16.38	8.52	17.50	16.99	58.90	28.87
Semiconductor Separated Parts	2.05	4.32	3.05	2.90	2.64	9.10	11.20
Integrated Circuits	2.92	3.39	4.92	3.10	2.25	17.82	25.21
5. Electronic Components	6.61	17.40	24.12	21.21	21.49	79.18	55.31
6. Household Audiovisual Equipment	6.45	24.09	45.64	86.75	106.71	86.68	181.00
7. Other Electronic Equipment	0.09	0.79	4.16	9.66	3.23	21.12	18.15
Manufacture of Computers and Office Equipment	5.47	18.59	72.61	44.91	76.55	115.54	107.12
1.Computers	3.75	13.96	54.65	21.75	36.85	101.23	41.08
2. Peripheral Equipment of Computer	1.36	4.56	16.86	21.04	39.16	12.78	63.43
3. Office Equipment	0.36	0.07	1.11	2.11	0.53	1.53	2.62
Manufacture of Medical Equipment and Meters	13.86	20.37	19.94	24.99	31.10	42.83	51.36
1.Medical Equipment and Instruments	1.53	2.85	4.08	6.87	4.49	7.49	6.84
2.Instruments and Meters	12.33	17.52	15.86	18.12	26.61	35.33	44.53

Source: China's Ministry of Science and Technology, 2002, forthcoming.

Annex Table A. 2
Value Added of High-Tech Industries
(100 million yuan, 1996 constant prices)

Industry	1995	1996	1997	1998	1999	2000	2001
Total	1112	1272	1545	1867	2258	2876	3269
Manufacture of Medical and Pharmaceutical Products	273	360	413	453	552	661	763
1.Chemical Pharmaceutical Products	159	196	211	247	308	358	414
2. Processing of Traditional Chinese Medicine	83	111	132	161	197	230	262
3. Biology Products	20	41	57	35	35	63	73
Manufacture of Aircraft and Spacecraft	82	74	98	91	99	110	131
1. Manufacture and Repair of Aircraft	72	65	89	82	87	96	114
2. Manufacture of Spacecraft	10	9	9	9	12	14	17
Electronic and Telecommunications Equipment	559	588	731	910	1202	1533	1714
1. Telecommunication Equipment	202	180	211	335	416	585	783
Telecommunication Transmission Unit	23	22	20	58	59	62	104
Telecommunication Exchange Unit	64	64	75	121	139	236	243
Telecommunication Terminal Unit	33	22	27	30	64	56	306
2. Radar and Peripheral Equipment	28	11	5	7	9	10	17
3.Broadcast and Television Equipment	5	6	4	5	6	9	8
4. Electronic Apparatus	126	125	116	114	193	260	234
Electronic Vacuum Apparatus	82	88	77	68	133	154	125
Semiconductor Separated Parts	17	21	16	18	25	34	55
Integrated Circuits	26	17	23	29	35	70	56
5. Electronic Components	98	111	144	175	253	284	320
6. Household Audiovisual Equipment	85	139	222	237	281	300	266
7. Other Electronic Equipment	17	17	27	37	45	87	84
Manufacture of Computers and Office Equipment	96	137	182	278	258	390	456
1.Computers	46	46	41	128	115	166	176
2. Peripheral Equipment of Computer	43	77	126	120	114	180	234
3. Office Equipment	6	13	14	30	30	44	45
Manufacture of Medical Equipment and Meters	103	113	121	135	147	181	204
1.Medical Equipment and Instruments	29	31	36	37	43	51	57
2.Instruments and Meters	74	83	85	99	104	130	147

Source: Value added data from China's Ministry of Science and Technology, 2002, forthcoming, deflated by ex-factory price index for industrial products from China Statistical Yearbook, 1999-2002, see Annex Table A.6.

Annex Table A. 3
Original Value of Fixed assets
(100 million yuan)

	1996	1997	1998	1999	2000	2001
Total	1964.97	2218.71	2495.46	2803.52	3141.49	4016.35
Manufacture of Medical and Pharmaceutical Products	471.94	527.64	599.08	651.54	732.04	860.62
1.Chemical Pharmaceutical Products	363.90	399.73	447.86	480.85	531.81	619.35
2. Processing of Traditional Chinese Medicine	79.60	93.34	115.91	120.60	136.21	165.32
3. Biology Products	21.26	27.04	28.81	43.46	58.54	68.58
Manufacture of Aircraft and Spacecraft	329.45	400.05	374.93	396.21	441.06	487.42
1. Manufacture and Repair of Aircraft	275.86	356.09	319.47	340.57	384.80	439.45
2. Manufacture of Spacecraft	53.58	43.95	55.46	55.64	56.26	47.96
Electronic and Telecommunications Equipment	892.03	998.25	1181.49	1408.26	1603.40	2209.79
1. Telecommunication Equipment	234.67	205.75	260.58	283.27	352.83	491.13
Telecommunication Transmission Unit	34.85	33.65	56.41	57.36	75.82	75.74
Telecommunication Exchange Unit	53.66	67.61	72.93	88.20	106.97	128.90
Telecommunication Terminal Unit	21.38	23.98	35.85	43.46	50.65	229.51
2. Radar and Peripheral Equipment	32.62	36.56	33.66	40.79	44.62	40.57
3.Broadcast and Television Equipment	8.00	8.00	7.90	7.96	8.40	7.69
4. Electronic Apparatus	293.59	305.85	422.76	542.38	597.74	844.47
Electronic Vacuum Apparatus	217.64	210.15	317.27	367.94	365.03	478.25
Semiconductor Separated Parts	33.68	34.90	36.17	45.28	48.94	117.73
Integrated Circuits	42.27	60.80	69.32	129.16	183.77	248.49
5. Electronic Components	164.90	184.80	236.17	268.15	308.45	474.07
6. Household Audiovisual Equipment	146.47	243.41	200.76	245.03	266.73	301.40
7. Other Electronic Equipment	11.77	13.88	19.65	20.67	24.63	50.47
Manufacture of Computers and Office Equipment	98.55	107.93	131.48	143.38	174.96	234.79
1.Computers	60.56	62.70	61.19	47.31	54.60	64.94
2. Peripheral Equipment of Computer	29.05	34.97	58.50	82.28	100.13	138.25
3. Office Equipment	8.95	10.26	11.79	13.79	20.23	31.60
Manufacture of Medical Equipment and Meters	172.99	184.84	208.49	204.14	190.04	223.74
1.Medical Equipment and Instruments	25.48	31.43	35.45	32.12	34.85	39.36
2.Instruments and Meters	147.51	153.41	173.04	172.02	155.19	184.38

Source: China’s Ministry of Science and Technology, 2002, Forthcoming

Annex Table A. 4
Labour Input in High-Tech Industry, 1995-2000
(persons engaged)

	1995	1996	1997	1998	1999	2000	2001	Growth rate, 1996-2001
Total	4484239	4610214	4304533	3926857	3844730	3899785	3983464	-2.8
Manufacture of Medical and Pharmaceutical Products	1157429	1186508	1157337	1037389	998826	995641	1029916	-2.7
1.Chemical Pharmaceutical Products	737936	746216	734871	661140	635089	612191	628985	-3.3
2. Processing of Traditional Chinese Medicine	318400	341082	313400	297271	285996	300633	304295	-2.1
3. Biology Products	45169	47613	57055	45347	46576	53451	69307	9.3
Manufacture of Aircraft and Spacecraft	590713	747422	537448	500309	494095	456531	417332	-10.5
1. Manufacture and Repair of Aircraft	478596	638448	461394	428969	429477	394176	364892	-10.1
2. Manufacture of Spacecraft	112117	108974	76054	71340	64618	62355	52440	-13.0
Electronic and Telecommunications Equipment	1815230	1773737	1715866	1652961	1663252	1737523	1768646	0.0
1. Telecommunication Equipment	310185	309759	327659	318600	316329	324066	341689	2.0
Telecommunication Transmission Unit		75557	74003	75783	72380	67149	67708	-2.1
Telecommunication Exchange Unit		76025	79110	80982	81897	84578	69076	-1.5
Telecommunication Terminal Unit		67286	78653	70892	70399	56902	108948	15.7
2. Radar and Peripheral Equipment	86164	84050	71719	67405	56156	54161	49376	-10.0
3.Broadcast and Television Equipment	37707	34975	33678	30548	24966	21404	23215	-7.4
4. Electronic Apparatus	297400	299759	287919	258913	261075	268611	263316	-2.5
Electronic Vacuum Apparatus		134878	133346	117895	115831	112600	108156	-4.2
Semiconductor Separated Parts		109874	102695	83684	82023	82007	91379	-3.1
Integrated Circuits		55007	51878	57334	63221	74004	63781	3.7
5. Electronic Components	633311	609640	569003	556413	581879	645061	677220	2.3
6. Household Audiovisual Equipment	374354	355753	348249	342679	322016	317255	304099	-3.1
7. Other Electronic Equipment	76109	79801	77639	78403	100831	106965	109731	7.1
Manufacture of Computers and Office Equipment	141771	144887	170843	214934	208973	238793	294665	15.7
1.Computers	53002	55917	65561	74377	66745	62331	83060	9.4
2. Peripheral Equipment of Computer	63491	64602	81813	102619	104452	125570	166950	21.4
3. Office Equipment	25278	24368	23469	37938	37776	50892	44655	16.0
Manufacture of Medical Equipment and Meters	779096	757660	723039	521264	479584	471297	472905	-8.4
1.Medical Equipment and Instruments	164722	157196	170248	123707	116109	117130	126930	-3.2
2.Instruments and Meters	614374	600464	552791	397557	363475	354167	345975	-9.9

Source: China's Ministry of Science and Technology, 2002, forthcoming.

Annex Table A. 5
Other Technological Inputs in High-Tech Industries, 1995-2001
(10 million current Yuan)

	1995	1996	1997	1998	1999	2000	2001
Total	1179.59	1057.34	1192.90	944.97	983.41	1623.73	2005.10
Manufacture of Medical and Pharmaceutical Products	314.73	218.05	227.49	245.27	228.52	404.43	425.67
1.Chemical Pharmaceutical Products	270.19	179.37	196.75	204.66	168.05	298.79	290.92
2. Processing of Traditional Chinese Medicine	37.76	33.03	21.95	34.65	48.25	88.79	110.35
3. Biology Products	6.50	2.94	7.58	5.38	11.99	16.57	23.69
Manufacture of Aircraft and Spacecraft	170.75	188.62	226.14	174.60	120.07	190.84	294.26
1. Manufacture and Repair of Aircraft	149.35	171.81	208.70	160.01	101.13	152.54	273.74
2. Manufacture of Spacecraft	21.40	16.81	17.44	14.59	18.95	38.30	20.52
Electronic and Telecommunications Equipment	594.35	551.53	575.11	413.90	496.82	842.04	1053.51
1. Telecommunication Equipment	39.86	130.89	182.23	126.47	142.57	158.58	310.93
Telecommunication Transmission Unit	6.50	47.19	19.54	31.13	18.21	23.43	19.94
Telecommunication Exchange Unit	20.75	67.26	135.66	76.53	111.52	47.90	39.66
Telecommunication Terminal Unit	7.11	10.05	10.55	3.65	3.68	80.07	212.25
2. Radar and Peripheral Equipment	39.90	28.08	15.31	5.28	6.60	9.25	16.77
3.Broadcast and Television Equipment	4.61	3.93	3.76	0.66	1.37	3.56	0.34
4. Electronic Apparatus	349.38	204.33	117.52	99.39	134.82	227.55	359.50
Electronic Vacuum Apparatus	325.84	153.35	97.16	90.34	107.93	129.58	216.40
Semiconductor Separated Parts	17.71	38.03	14.07	4.69	8.92	29.59	48.72
Integrated Circuits	5.83	12.94	6.29	4.37	17.96	68.38	94.37
5. Electronic Components	98.00	110.14	160.26	68.48	99.24	297.83	149.46
6. Household Audiovisual Equipment	55.92	62.09	86.53	108.82	111.31	121.08	213.65
7. Other Electronic Equipment	6.67	12.07	9.50	4.80	0.91	24.19	2.86
Manufacture of Computers and Office Equipment	19.24	29.94	75.99	65.05	92.41	113.08	154.49
1.Computers	11.09	9.86	43.88	8.96	36.42	46.94	63.75
2. Peripheral Equipment of Computer	7.80	19.89	30.34	56.07	54.98	65.68	66.37
3. Office Equipment	0.35	0.20	1.77	0.02	1.01	0.46	24.37
Manufacture of Medical Equipment and Meters	80.51	69.20	88.18	46.15	45.58	73.33	77.17
1.Medical Equipment and Instruments	7.74	3.23	21.16	5.24	4.59	14.79	12.54
2.Instruments and Meters	72.77	65.97	67.02	40.90	40.99	58.55	64.63

Source: China's Ministry of Science and Technology, 2002, forthcoming.

Annex Table A. 6

Price Indices, 1996 =100	Ex-Factory Price Indices of Industrial Products	Investment in Fixed Assets Price index		Consumer Price Index (CPI)	Export price index	GDP Deflator
		Structure	Equipment			
	97.2	…	…	…	…	…
1996	100	100	100	100	100	100
1997	99.7	102.9	98.1	102.8	…	100.8
1998	95.6	103.4	95.6	102.0	60.1	98.3
1999	93.3	103.7	93.3	100.5	48.1	96.2
2000	95.9	106.2	90.8	101.0	51.9	97.1
2001	94.7	107.7	88.1	101.7	52.4	97.0

Sources: National Bureau of Statistics of China (NBS), 1999-2002, China Statistical Yearbook (1999-2002), China's Statistics Press

2. Other Data Estimated

Annex Table A. 7
. R&D Capital during 1995-2001
(10 million 1996 yuan)

Industries	1995	1996	1997	1998	1999	2000	2001
Total	10.175	10.512	12.031	14.418	18.076	22.496	30.628
Manufacture of Medical and Pharmaceutical Products	2.439	2.520	2.707	2.961	3.305	3.787	4.614
Chemical Pharmaceutical Products	1.864	1.926	2.058	2.243	2.505	2.783	3.281
Processing of Traditional Chinese Medicine	0.410	0.424	0.456	0.479	0.540	0.687	0.887
Biology Products	0.154	0.159	0.178	0.222	0.242	0.295	0.423
Manufacture of Aircraft and Spacecraft	3.710	3.832	4.226	4.417	4.481	4.725	5.445
1.Manufacture and Repair of Aircraft	3.003	3.102	3.540	3.732	3.742	3.791	4.458
2. Manufacture of Spacecraft	0.707	0.730	0.686	0.684	0.739	0.934	0.988
Electronic and Telecommunications Equipment	2.924	3.021	3.741	4.963	7.804	10.735	16.165
1. Telecommunication Equipment	1.138	1.176	1.456	2.031	3.797	5.623	8.899
Telecommunication Transmission Unit	0.262	0.271	0.271	0.330	0.506	0.628	1.196
Telecommunication Exchange Unit	0.582	0.601	0.806	1.220	2.745	4.357	6.621
Telecommunication Terminal Unit	0.149	0.154	0.177	0.213	0.230	0.313	0.387
2.Radar and Peripheral Equipment	0.321	0.331	0.321	0.351	0.354	0.383	0.398
3. Broadcast and Television Equipment	0.046	0.048	0.055	0.057	0.051	0.050	0.063
4. Electronic Apparatus	0.669	0.691	0.828	0.869	0.981	1.064	1.794
Electronic Vacuum Apparatus	0.386	0.398	0.502	0.512	0.616	0.703	1.208
Semiconductor Separated Parts	0.117	0.121	0.146	0.154	0.161	0.165	0.234
Integrated Circuits	0.166	0.172	0.180	0.202	0.204	0.197	0.352
5.Electronic Components	0.377	0.390	0.505	0.670	0.788	0.897	1.583
6. Household Audiovisual Equipment	0.368	0.380	0.564	0.934	1.689	2.562	3.076
7. Other Electronic Equipment	0.005	0.005	0.012	0.052	0.144	0.156	0.352
Manufacture of Computers and Office Equipment	0.312	0.322	0.460	1.115	1.411	2.007	2.904
1. Computers	0.214	0.221	0.327	0.824	0.924	1.175	2.048
2.Peripheral Equipment of Computer	0.077	0.080	0.114	0.265	0.442	0.789	0.803
3. Office Equipment	0.021	0.021	0.019	0.027	0.045	0.044	0.053
Manufacture of Medical Equipment and Meters	0.790	0.816	0.898	0.962	1.075	1.242	1.500
1. Medical Equipment and Instruments	0.087	0.090	0.105	0.130	0.181	0.201	0.249
2.Instruments and Meters	0.703	0.727	0.793	0.832	0.894	1.041	1.251

Sources: National Bureau of Statistics of China (NBS), 1999-2002, China Statistical Yearbook (1999-2002), China's Statistics Press; China's Ministry of Science and Technology, 2002, forthcoming

Annex Table A. 8
Incremental Capital Value Added Ratios (ICVARs), 1997-2001
(ratios at current prices)

Industry	1997 /1996	1998 /1997	1999 /1998	2000 /1999	2001 /2000	Average
Total	0.947	1.130	0.957	0.518	2.604	1.231
Manufacture of Medical and Pharmaceutical Products	1.071	3.402	0.640	0.676	1.461	1.450
1.Chemical Pharmaceutical Products	2.559	1.851	0.647	0.910	1.787	1.551
2. Processing of Traditional Chinese's Medicine	0.654	1.026	0.156	0.422	1.078	0.667
3. Biology Products	0.361	-0.074	...	0.559	1.116	0.491
Manufacture of Aircraft and Spacecraft	2.942	2.284	4.256	3.204	2.575	3.052
1.Manufacture and Repair of Aircraft	3.343	3.330	7.035	4.020	3.416	4.229
2. Manufacture of Spacecraft	...	...	0.089	0.313	-2.766	-0.788
Electronic and Telecommunications Equipment	0.753	1.300	0.900	0.559	3.989	1.500
1. Telecommunication Equipment	-0.964	0.499	0.334	0.402	0.768	0.208
Telecommunication Transmission Unit	0.598	0.650	...	4.616	-0.002	1.466
Telecommunication Exchange Unit	1.268	0.130	1.090	0.196	5.483	1.633
Telecommunication Terminal Unit	0.520	5.938	0.245	-1.199	0.758	1.252
2. Radar and Peripheral Equipment	-0.656	-1.450	7.134	1.912	-0.674	1.253
3. Broadcast and Television Equipment	0.001	-0.106	0.061	0.147	0.708	0.162
4.Electronic Apparatus	-1.362	-16.702	1.685	0.802	-9.138	-4.943
Electronic Vacuum Apparatus	0.681	-8.927	0.859	-0.121	-3.774	-2.256
Semiconductor Separated Parts	-0.244	1.268	1.519	0.366	3.620	1.306
Integrated Circuits	3.088	1.704	11.967	1.606	-4.623	2.749
5.Electronic Components	0.603	2.234	0.463	1.119	5.342	1.952
6. Household Audiovisual Equipment	1.182	-7.108	1.265	0.834	-0.963	-0.958
7. Other Electronic Equipment	0.211	0.721	0.145	0.097	-8.611	-1.487
Manufacture of Computers and Office Equipment	0.213	0.277	-0.476	0.237	1.032	0.257
1. Computers	-0.428	-0.019	0.925	0.140	1.291	0.382
2.Peripheral Equipment of Computer	0.121	-2.139	-2.642	0.266	0.778	-0.723
3. Office Equipment	1.316	0.102	-1.993	0.460	11.378	2.253
Manufacture of Medical Equipment and Meters	1.481	2.956	-0.544	-0.381	1.774	1.057
1.Medical Equipment and Instruments	1.188	-4.020	-0.666	0.304	0.902	-0.458
2.Instruments and Meters	2.953	1.963	-0.510	-0.601	2.085	1.178

Sources: China's Ministry of Science and Technology, 2002, forthcoming

Annex Table A. 9
Assets Estimated in 1996 by ICVAR
(100 million 1996 yuan)

Industries	Fixed assets	Structures	Equipment
Total	1565.89	1203.98	361.90
Manufacture of Medical and Pharmaceutical Products	443.18	340.75	102.43
1.Chemical Pharmaceutical Products	241.28	185.52	55.76
2. Processing of Traditional Chinese Medicine	136.65	105.06	31.58
3. Biology Products	50.47	38.81	11.67
Manufacture of Aircraft and Spacecraft	91.10	70.04	21.05
1.Manufacture and Repair of Aircraft	80.02	61.52	18.49
2. Manufacture of Spacecraft	11.08	8.52	2.56
Electronic and Telecommunications Equipment	723.85	556.56	167.29
1. Telecommunication Equipment	221.59	170.37	51.21
Telecommunication Transmission Unit	27.08	20.82	6.26
Telecommunication Exchange Unit	78.79	60.58	18.21
Telecommunication Terminal Unit	27.08	20.82	6.26
2. Radar and Peripheral Equipment	13.54	10.41	3.13
3. Broadcast and Television Equipment	7.39	5.68	1.71
4.Electronic Apparatus	153.88	118.32	35.56
Electronic Vacuum Apparatus	108.33	83.29	25.04
Semiconductor Separated Parts	25.85	19.88	5.97
Integrated Circuits	20.93	16.09	4.84
5.Electronic Components	136.65	105.06	31.58
6. Household Audiovisual Equipment	171.11	131.57	39.55
7. Other Electronic Equipment	20.93	16.09	4.84
Manufacture of Computers and Office Equipment	168.65	129.67	38.98
1. Computers	56.63	43.54	13.09
2.Peripheral Equipment of Computer	94.79	72.88	21.91
3. Office Equipment	17.11	12.30	3.70
Manufacture of Medical Equipment and Meters	233.93	106.96	32.15
1.Medical Equipment and Instruments	32.39	29.34	8.82
2.Instruments and Meters	193.69	78.56	23.61

Sources: National Bureau of Statistics of China (NBS), 1999-2002, China Statistical Yearbook(1999-2002), China's Statistics Press; China's Ministry of Science and Technology, 2002, forthcoming

Annex Table A. 10
Net Investment in Fixed Structures
(100 million, 1996 prices)

Industries	1997	1998	1999	2000	2001
Total	188.23	209.64	232.35	260.29	680.39
Manufacture of Medical and Pharmaceutical Products	41.32	54.11	39.57	62.00	99.99
1.Chemical Pharmaceutical Products	26.57	36.46	24.88	39.24	68.08
2. Processing of Traditional Chinese Medicine	10.19	17.10	3.53	12.03	22.63
3. Biology Products	4.29	1.34	11.04	11.62	7.81
Manufacture of Aircraft and Spacecraft	52.37	-19.03	16.05	34.54	36.05
1.Manufacture and Repair of Aircraft	59.52	-27.74	15.92	34.06	42.51
Electronic and Telecommunications Equipment	78.79	138.80	171.03	150.29	471.60
1. Telecommunication Equipment	-21.46	41.54	17.12	53.57	107.56
Telecommunication Transmission Unit	-0.89	17.24	0.71	14.22	-0.06
Telecommunication Exchange Unit	10.35	4.03	11.51	14.46	17.06
Telecommunication Terminal Unit	1.93	9.00	5.73	5.54	139.10
2. Radar and Peripheral Equipment	2.92	-2.20	5.38	2.95	-3.15
3. Broadcast and Television Equipment	0.00	-0.08	0.05	0.34	-0.55
4.Electronic Apparatus	9.09	88.56	90.22	42.64	191.88
Electronic Vacuum Apparatus	-5.56	81.15	38.21	-2.24	88.05
Semiconductor Separated Parts	0.90	0.96	6.87	2.82	53.49
Integrated Circuits	13.75	6.46	45.13	42.06	50.33
5.Electronic Components	14.76	38.91	24.12	31.04	128.80
6. Household Audiovisual Equipment	71.91	-32.30	33.39	16.71	26.97
7. Other Electronic Equipment	1.56	4.37	0.77	3.05	20.09
Manufacture of Computers and Office Equipment	6.96	17.84	8.97	24.32	46.53
1. Computers	1.59	-1.14	-10.47	5.62	8.03
2.Peripheral Equipment of Computer	4.39	17.82	17.93	13.75	29.65
3. Office Equipment	0.98	1.16	1.50	4.96	8.85
Manufacture of Medical Equipment and Meters	8.79	17.91	-3.28	-10.86	26.21
1.Medical Equipment and Instruments	4.41	3.05	-2.51	2.11	3.51
2.Instruments and Meters	4.38	14.87	-0.77	-12.97	22.70

Sources: National Bureau of Statistics of China (NBS), 1999-2002, China Statistical Yearbook(1999-2002), China’s Statistics Press; China’s Ministry of Science and Technology, 2002, forthcoming

Annex Table A. 11
Net Investment in Equipment
(100 million Yuan, at 1996 prices)

Industries	1997	1998	1999	2000	2001
Total	69.47	70.82	78.39	84.39	214.20
Manufacture of Medical and Pharmaceutical Products	15.25	18.28	13.35	20.10	31.48
1.Chemical Pharmaceutical Products	9.81	12.32	8.40	12.72	21.43
2. Processing of Traditional Chinese Medicine	3.76	5.78	1.19	3.90	7.13
3. Biology Products	1.58	0.45	3.73	3.77	2.46
Manufacture of Aircraft and Spacecraft	19.33	-6.43	5.42	11.20	11.35
1.Manufacture and Repair of Aircraft	21.97	-9.37	5.37	11.04	13.38
Electronic and Telecommunications Equipment	29.08	46.89	57.70	48.73	148.47
1. Telecommunication Equipment	-7.92	14.03	5.77	17.37	33.86
Telecommunication Transmission Unit	-0.33	5.82	0.24	4.61	-0.02
Telecommunication Exchange Unit	3.82	1.36	3.88	4.69	5.37
Telecommunication Terminal Unit	0.71	3.04	1.93	1.80	43.79
2. Radar and Peripheral Equipment	1.08	-0.74	1.82	0.96	-0.99
3. Broadcast and Television Equipment	0.00	-0.03	0.02	0.11	-0.17
4.Electronic Apparatus	3.36	29.92	30.44	13.82	60.41
Electronic Vacuum Apparatus	-2.05	27.41	12.89	-0.73	27.72
Semiconductor Separated Parts	0.33	0.32	2.32	0.91	16.84
Integrated Circuits	5.07	2.18	15.23	13.64	15.85
5.Electronic Components	5.45	13.15	8.14	10.06	40.55
6. Household Audiovisual Equipment	26.54	-10.91	11.26	5.42	8.49
7. Other Electronic Equipment	0.58	1.48	0.26	0.99	6.33
Manufacture of Computers and Office Equipment	2.57	6.03	3.03	7.89	14.65
1. Computers	0.59	-0.39	-3.53	1.82	2.53
2.Peripheral Equipment of Computer	1.62	6.02	6.05	4.46	9.33
3. Office Equipment	0.36	0.39	0.51	1.61	2.79
Manufacture of Medical Equipment and Meters	3.24	6.05	-1.11	-3.52	8.25
1.Medical Equipment and Instruments	1.63	1.03	-0.85	0.68	1.10
2.Instruments and Meters	1.62	5.02	-0.26	-4.20	7.15

Sources: National Bureau of Statistics of China (NBS), 1999-2002, *China Statistical Yearbook* (1999-2002), China's Statistics Press; China's Ministry of Science and Technology, 2002, forthcoming.

Annex Table A. 12
Net Stock of Fixed Assets in High-Tech Industries, 1996-2001
(100 million, constant 1996 yuan)

Industries	1996	1997	1998	1999	2000	2001	growth rate, 1996-2001
Total	1565.9	1753.5	1956.3	2181.2	2431.3	3221.5	15.8
Manufacture of Medical and Pharmaceutical Products	443.2	474.8	520.6	544.3	595.9	694.1	9.5
1.Chemical Pharmaceutical Products	241.3	264.1	298.0	314.6	348.9	418.9	11.8
2. Processing of Traditional Chinese Medicine	136.6	142.9	157.8	153.7	161.0	181.8	6.0
3. Biology Products	50.5	53.5	52.3	64.1	75.9	82.0	10.5
Manufacture of Aircraft and Spacecraft	91.1	159.2	127.3	143.8	184.0	224.3	23.5
1. Manufacture and Repair of Aircraft	80.0	158.3	114.8	131.6	171.6	220.8	28.8
2. Manufacture of Spacecraft	11.1	11.9	12.5	12.2	12.4	13.5	4.1
Electronic and Telecommunications Equipment	723.9	802.3	955.8	1146.5	1300.1	1869.3	21.4
1. Telecommunication Equipment	221.6	183.2	231.6	245.4	306.9	436.4	16.5
Telecommunication Transmission Unit	27.1	24.8	46.9	45.9	62.9	60.4	22.3
Telecommunication Exchange Unit	78.8	89.8	91.5	103.3	118.4	136.2	11.7
Telecommunication Terminal Unit	27.1	28.6	39.5	45.6	51.1	232.0	85.0
2. Radar and Peripheral Equipment	13.5	17.0	13.4	20.0	23.1	18.1	9.6
3. Broadcast and Television Equipment	7.4	7.1	6.7	6.5	6.7	5.7	-4.9
4.Electronic Apparatus	153.9	160.1	272.2	381.8	422.9	658.4	36.2
Electronic Vacuum Apparatus	108.3	96.3	201.1	244.0	231.3	338.0	32.0
Semiconductor Separated Parts	25.9	26.0	26.3	34.5	36.8	105.7	45.3
Integrated Circuits	20.9	38.9	45.9	104.4	155.8	215.6	63.8
5.Electronic Components	136.6	151.3	197.3	221.7	254.0	413.4	26.2
6. Household Audiovisual Equipment	171.1	262.6	208.6	245.0	257.5	282.9	13.1
7. Other Electronic Equipment	20.9	22.2	27.2	27.1	30.1	55.4	24.7
Manufacture of Computers and Office Equipment	168.7	171.5	188.7	193.4	218.3	271.3	10.3
1. Computers	56.6	56.6	52.8	36.8	42.9	52.0	0.2
2.Peripheral Equipment of Computer	94.8	97.1	117.1	136.6	149.5	182.8	14.3
3. Office Equipment	16.0	16.7	17.6	18.9	24.8	35.5	18.3
Manufacture of Medical Equipment and Meters	139.1	145.6	163.9	153.2	133.0	162.6	4.0
1.Medical Equipment and Instruments	38.2	42.7	45.1	40.0	41.3	44.3	3.3
2.Instruments and Meters	102.2	104.1	120.0	114.3	92.8	119.3	4.4

Sources: National Bureau of Statistics of China (NBS), 1999-2002, China Statistical Yearbook(1999-2002), China's Statistics Press; China's Ministry of Science and Technology, 2002, forthcoming

Annex Table A. 13
Capital Intensity in High-Tech Industries, 1996-2001
(Net Stock of Fixed Assets per Person Engaged, constant 1996 yuan)

Industries	1996	1997	1998	1999	2000	2001	growth rate, 1996-2001
Total	33966	40736	49818	56732	62344	80872	19.1
Manufacture of Medical and Pharmaceutical Products	37353	41025	50184	54494	59851	67394	12.6
1.Chemical Pharmaceutical Products	32336	35938	45074	49536	56992	66599	15.7
2. Processing of Traditional Chinese Medicine	40049	45597	53083	53742	53554	59745	8.5
3. Biology Products	106063	93769	115333	137625	141999	118314	3.4
Manufacture of Aircraft and Spacecraft	12189	29621	25444	29104	40304	53746	43.0
2. Manufacture and Repair of Aircraft	12530	34309	26762	30642	43534	60511	49.5
2. Manufacture of Spacecraft	10186	15647	17522	18880	19886	25744	21.6
Electronic and Telecommunications Equipment	40812	46758	57824	68931	74825	105691	21.4
1. Telecommunication Equipment	71539	55912	72693	77577	94703	127718	14.4
Telecommunication Transmission Unit	35867	33512	61887	63415	93672	89207	24.7
Telecommunication Exchange Unit	103650	113513	112988	126134	139989	197174	14.5
Telecommunication Terminal Unit	40276	36362	55719	64774	89804	212946	47.1
2. Radar and Peripheral Equipment	16062	23704	19880	35615	42651	36657	23.3
3. Broadcast and Television Equipment	21158	21082	21933	26035	31303	24553	4.2
4.Electronic Apparatus	51341	55606	105132	146242	157440	250042	40.6
Electronic Vacuum Apparatus	80295	72218	170576	210652	205417	312512	39.9
Semiconductor Separated Parts	23572	25318	31428	42061	44874	115672	46.0
Integrated Circuits	37995	74984	80057	165135	210529	338032	59.7
5.Electronic Components	22407	26590	35459	38101	39376	61044	23.6
6. Household Audiovisual Equipment	48095	75406	60873	76083	81165	93029	16.8
7. Other Electronic Equipment	26190	28594	34693	26877	28140	50487	18.4
Manufacture of Computers and Office Equipment	116436	100385	87794	92548	91418	92071	-4.3
1. Computers	101221	86332	70990	55135	68826	62605	-7.8
2.Peripheral Equipment of Computer	146745	118685	114111	130778	119057	109494	-5.1
3. Office Equipment	65660	71158	46391	50032	48731	79498	8.4
Manufacture of Medical Equipment and Meters	18359	20137	31443	31944	28220	34383	15.5
1.Medical Equipment and Instruments	24301	25081	36457	34450	35260	34901	8.9
2.Instruments and Meters	17020	18832	30184	31446	26202	34482	18.0

Sources: Net Fixed Capital Stock from Annex table A.12, labour input from Annex table A. 4

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