Unclassified **DSTI/DOC(2004)4**

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development **22-Mar-2004**

English text only

DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY

DSTI/DOC(2004)4
Unclassified

AN EMERGING KNOWLEDGE-BASED ECONOMY IN CHINA? INDICATORS FROM OECD DATABASES

STI WORKING PAPER 2004/4
Statistical Analysis of Science, Technology and Industry

Martin Schaaper

English text only

JT00160520

AN EMERGING KNOWLEDGE-BASED ECONOMY IN CHINA? INDICATORS FROM OECD DATABASES

Martin Schaaper*

FOREWORD

In October 2003, the OECD Directorate for Science, Technology and Industry (DSTI) published its biennial *Science, Technology and Industry Scoreboard*. For the first time in its ten-year history, this publication included a section on the state of affairs in the fields of R&D expenditures, human resources in science and technology and patenting in a number of important non-OECD economies, such as China, India and Brazil. This was possible because of the resources provided by the OECD Centre for Co-operation with Non-Members (CCNM), and the inclusion in its work programme of the diffusion of OECD developed and tested methodologies in the area of science and technology indicators to non-OECD economies. In the *Scoreboard*, the data for China in particular generated considerable attention. For this reason, and because of the general interest for China, the Economic Analysis and Statistics Division (EAS) of the DSTI decided to produce an experimental "mini-Scoreboard" for China, with the support of CCNM.

The main objective of this Working Paper is to show a set of indicators on the knowledge-based economy for China, mainly compiled from databases within EAS, although data from databases maintained by other parts of the OECD are included as well. These indicators will be put in context by comparing them with data for the Triad – the United States, Japan and the EU (or the G7 countries in case no EU totals are available) – as well as with data for some of the dynamic Asian neighbours of China, *in casu* Korea, Singapore, Chinese Taipei and Hong Kong, China, in so far data for these countries were easily available.

This document draws heavily on the *Science, Technology and Industry Scoreboard*, copying many of the indicators presented there and borrowing a substantial amount of contextual and methodological explanations. After listing the main outcomes of this study, the paper starts with a section on the economic structure of China and the other economies. This is followed by a set of trade indicators, showing the opening up of China's economy and the growing importance of trade in high-technology products. The next section looks at two indicators of foreign investment in China, through foreign affiliates (at least 50% control) and through foreign direct investment (at least 10% control). Human resources are essential for a knowledge-based economy, which is why the following section portrays a large selection of human resources indicators. The last two sections present indicators on one of the inputs into the innovation process, R&D indicators, and on one of the outputs of the innovation process, through patent indicators. After the conclusions, a statistical annex brings together a selection of tables of the main indicators shown in this document.

Eric Burgeat
Director
Centre for Co-operation with Non-Members

---

* OECD; Directorate for Science, Technology and Industry; Economic Analysis and Statistics Division. E-mail: martin.schaaper@oecd.org.
This paper has benefited greatly from comments and suggestions from many colleagues, both inside and outside the Economic Analysis and Statistics Division. All remaining errors are those of the author.

MAIN RESULTS

This paper shows that China is catching up rapidly with other dynamic Asian economies and the Triad economies on a score of indicators relating to the knowledge-based economy. Taking into account that a number of measurement issues hamper international comparability to varying degrees, some of the main results are the following.

- Economic growth in China has outpaced the other economies substantially. Nevertheless, GDP per capita is still considerably smaller than that of the other economies.

- The main contributor to GDP in China is industry (mining; manufacturing; electricity, gas and water supply; and construction), which saw its share rise by 10 percentage points to 52% between 1990 and 2002.

- Trade in goods as a percentage of GDP doubled between 1990 and 2002, reaching a level well above that of the Triad economies. The largest contribution to this expansion was made by high-technology manufacturing.

- Trade data for ICT goods give rise to the notion of China as an importer of ICT components for assembly in China, after which the finalised products are exported back to the rest of the world, mostly to the United States, followed by the EU and Japan.

- China was the world's largest recipient of FDI in 2002, with almost USD 50 billion of inflows. Based on turnover per employee data of foreign affiliates in China, a tentative conclusion can be drawn that multinationals are using China for the production of low-technology goods.

- Although large in absolute numbers, only a small part of the population in China has a tertiary education degree.

- The absolute number of enrolments in, and graduates from tertiary education in China match the numbers in the United States and the EU. China's level of enrolments in and graduation from advanced research programmes, such as PhDs, is still low compared to the other economies.

- A substantial number of Chinese students enrol in OECD countries, at least half of them in the United States.

- There has been a huge expansion in the number of researchers in China since 1999. China counts now more researchers than Japan, and is on its way to potentially overtake the EU as well.

- The amount of money spent on R&D increased even faster than the researchers base. R&D intensity has been rising rapidly, and China seems poised to reach its target of spending 1.5% of GDP on R&D in 2005.

- China's share in patent grants or applications at the US Patent and Trademark Office and the European Patent Office is still very small. The level of international co-operation in science and technology – as measured by patent applications owned or co-owned by foreign residents and patents with foreign co-inventors – turns out to be higher for China than for the Triad economies.

TABLE OF CONTENTS

Boxes

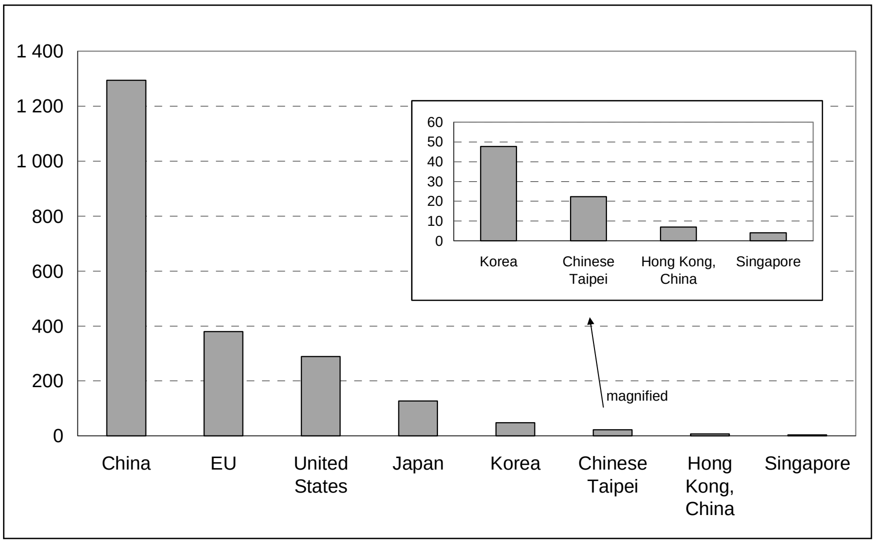
ECONOMIC STRUCTURE

This first section puts the countries and economies that form the subject of this paper into context, by looking at the size and structure of their respective economies.

Population

Figure 1 shows the 2002 population of the economies examined in this document. Immediately apparent is the enormous size of China compared with the other economies. At almost 1.3 billion, China's population was 1.6 times the size of the population of the EU, the United States and Japan combined. This needs to be kept in mind when making any comparison between China and other economies. Compared with China, the population sizes of the smaller economies in the figure seem almost insignificant. Nevertheless, Korea had a population of 48 million, just more than double the size of Chinese Taipei at 22 million. Finally, Hong Kong, China and Singapore both have very small populations of respectively 7 and 4 million people.

Figure 1. Population, 2002 (millions)



Source: OECD, Main Economic Indicators database and IMF, International Financial Statistics.

Gross Domestic Product

China's GDP has been growing rapidly over the past decade. Exactly how fast, however, is difficult to say, as there are several difficulties in comparing China's GDP over time and with that of other economies. Box 1 highlights the most pressing issues.

Box 1. Comparing financial data for China with other countries

To compare financial data over time and between countries, two types of conversion series are needed.

To make intertemporal comparisons, account has to be taken of price level changes within a country. The most widely used rate to do this is the implicit GDP deflator, which is calculated as GDP in current prices divided by GDP in constant prices. The deflator used for this report is taken from the World Development Indicators from the World Bank.

Often, exchange rates are used to express GDPs or other financial series of countries in a common currency for the purpose of international comparison. The assumption underlying this practice is that exchange rates reflect the relative prices of domestically-produced goods and services in different countries. However, many goods and services, such as buildings and government services, are not traded between countries. Moreover, other factors, such as relative interest rates, currency controls and capital flows between countries, also have a significant impact on exchange rates and their influence is such that exchange rates do not adequately reflect the relative purchasing power of currencies in their national markets. Hence, when GDPs of countries are converted to a common currency using exchange rates, they remain valued at national prices and reflect not only differences in the quantities produced in the countries, but also differences in the price levels of the countries.

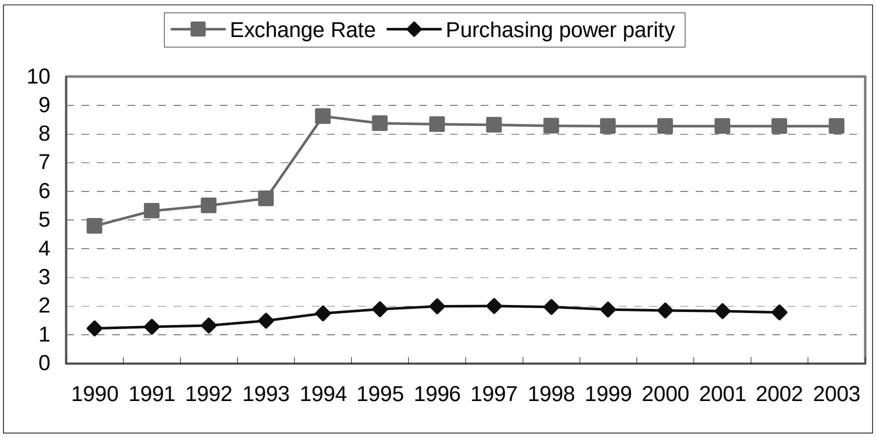
In the case of China, this is particularly apparent. Even though China operates a managed floated rate system, the exchange rate of the Yuan against the US dollar shows little fluctuation. As can be seen in Figure 2, the exchange rate has been virtually unchanged since 1994. The overall movement between the beginning of 1994 and end-2002 was a mere -4.9% and this reflects the interplay of supply and demand on the Yuan foreign currency market, itself influenced by the exchange rate policy and open market operations by the People's Bank of China. Thus, the exchange rate is hardly a plausible measure of relative prices and relative price structures between the United States and China which are unlikely to have evolved in such a linear way as the exchange rate would suggest. This reinforces the case for computing purchasing power parities (PPPs) and speaks against the use of exchange rates in many international comparisons with China.

In order to effect a bilateral comparison between China and – for example – the United States, it is necessary to calculate the currency conversion rates that will equate the purchasing power of the two currencies, the Yuan and the US dollar. Such conversion rates are called "purchasing power parities" (PPPs). When compared to market exchange rates, they yield a measure of comparative price levels and so permit volume comparisons. Currently, there is no PPP rate for China equivalent to the OECD-Eurostat PPP rates. The Penn World Tables of the University of Pennsylvania (Heston *et al.* 2002) constitute a long-standing source for world-wide PPP and GDP per capita comparisons that are also used in the World Bank's World Development Indicators publication. For China, the data in the Penn World Tables have to rely on statistical sources that are themselves surrounded by uncertainty. This limits their suitability for using these series for comparisons with the other countries in the present study.

The disparity between the exchange rate and the purchasing power parity is shown in Figure 2. One reason for the large gap between the PPP and the exchange rate is the so-called "Balassa-Samuelson effect" (see Balassa (1964) and Samuelson (1964)), which states that the price level of a country (the ratio of PPPs to the exchange rate) will rise with its level of income. The main reason for this is that price levels of tradables (*e.g.* manufacturing goods) are determined in the world market. With fixed price levels, wages depend on real productivity in tradables. On the other hand, price of non-tradables (services) are set in the domestic market. The wage level of the tradable sector will also prevail in the production of non-tradables, even though real productivity in non-tradables is typically less different between countries than real productivity in tradables. In low income countries, the low wages (due to low productivity) set in the tradable sectors lead to low wages in non-tradables and therefore to low national price levels.

Some alternative PPP conversion rates have been developed. For the year 1990, Maddison (2001) estimates a multilateral PPP conversion rate of 0.9273, based on an estimate for 1986 by Ren (1997). This result was derived from a 1987 bilateral China/United States comparison), adjusted to a Geary–Khamis basis as described in Maddison (1998), pp. 153-4, and is lower than the World Bank estimate of 1.23 for that year. For 1995, Bai *et al.* (2002) present an estimate of the price level for manufacturing only of Yuan 4.5 to the dollar, which is somewhere in the middle between the World Bank PPP rate of 1.89 and the official exchange rate of 8.37.

Figure 2. Purchasing power parity vs. exchange rate, national currency per dollar



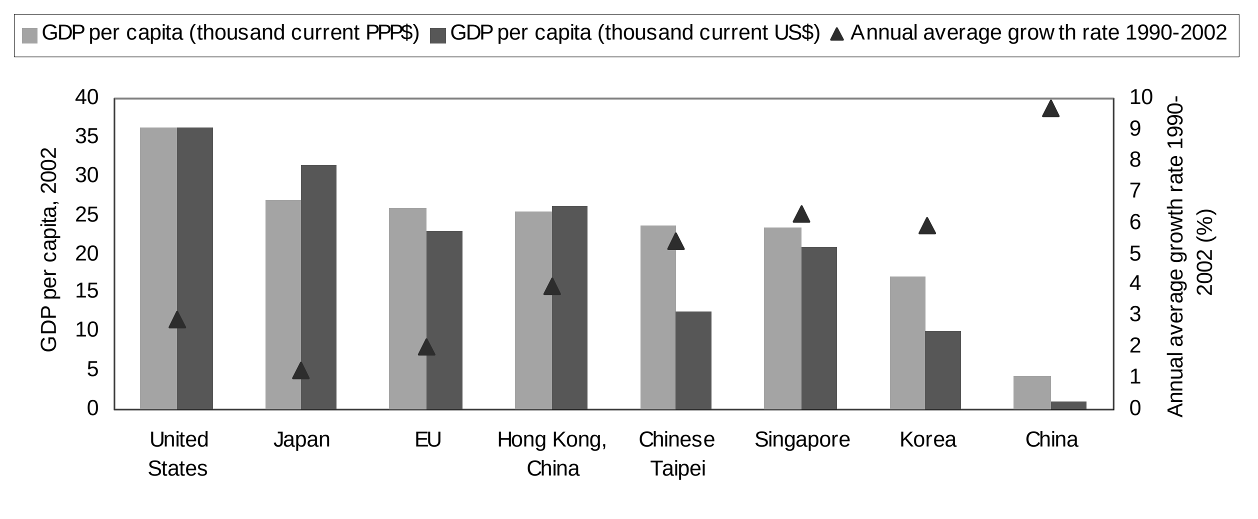
Source: OECD, Main Economic Indicators database and World Bank, World Development Indicators.

It is probably fair to consider the PPP rates as a lower bound and the exchange rates as an upper bound for the purpose of international comparisons of financial data. Figure 3 gives a sense of this range by showing GDP per capita in US dollars using both the exchange rate and the PPP. At which point between the two rates, however, to find the most suitable conversion rate is currently not possible to identify.

Figure 3 shows GDP per capita in 2002, using the left hand axis, and annual average growth rates of GDP per capita (in constant national prices), using the right hand axis. The GDP per capita bars are shown in current USD, using exchange rates, as well as in current PPP dollars. It shows that of the Asian countries, Singapore and Hong Kong, China have caught up already with EU income levels, as has Chinese Taipei when using PPPs. China, on the other hand, still has a very low GDP per capita, whether measured in USD or in PPPs. However, the gap is much smaller when PPPs are used as a conversion rate. As stated in Box 1, the "real" GDP per capita is likely to lie somewhere in between those two estimates. What the figure shows is that China is still a developing country, where despite impressive growth in the coastal regions and the big cities, there is still a large rural base with very low income levels.

Real economic growth, based on annual average growth rates of GDP in constant national currencies between 1990 and 2002, has been relatively sluggish in Japan and the EU, 0.9 to 1.6 percentage points below the level found for the United States. The economies of Singapore, Korea and Chinese Taipei grew considerably faster, with annual average GDP growth rates between 5.4% and 6.3%. The fastest growth, however, was registered by China, with an average GDP growth rate of almost 10% per annum.

Figure 3. GDP per capita (2002) and real GDP growth (1990-2002)



Note: annual average growth rates are based on 1995 constant prices in national currency, except for Hong Kong, China, which is based on 2000 constant prices in national currency; growth rate for the EU is for 1991-2002.

Source: OECD, National Accounts and Main Economic Indicators databases; Eurostat NewCronos database; World Bank, World Development Indicators; IMF, International Financial Statistics; and OECD, based on national sources.

Gross value added

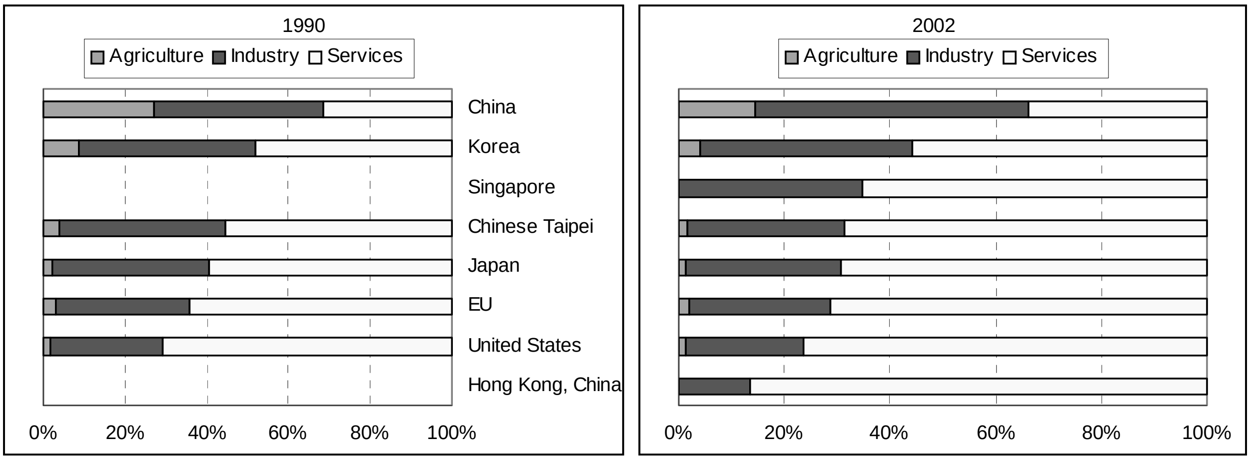
Instead of looking at levels of GDP, the composition of GDP also provides indicators about the state and functioning of an economy. It is well known that in developed economies, services are becoming increasingly important, at the expense of industry and agriculture.

For China the share of agriculture in total GDP has declined to 14.5% in 2002, down from 27.1% in 1990 (see Figure 4). The current level, however, is still much higher than the share in the other economies. In general, in developed countries less than 5% of value added is generated in agriculture. The figure supports this claim, with agricultural shares between 0.1% for Singapore and 3.9% for Korea. This country is a good example of a country that has developed rapidly over the last decade. In its transition to a more knowledge-based economy, the share of agriculture declined from 8.5% in 1990 to 3.9% in 2002.

For industry as well, the share in total gross value added declined for all economies studied during the 1990s, with the major exception of China. With a share already above that of the other economies, the industrial contribution to GDP moved to 51.7% in 2002, up from 41.6% in 1990. This supports the notion of China increasingly becoming one of the world's major sources of manufactured goods.

In China, most of the decline in agriculture was absorbed by industry, and not by services. The share of services in GDP grew from 31.3% in 1990 only to 33.7% in 2002. Starting with shares already much higher than the Chinese share, the other economies also registered larger increases in the period 1990-2002. Except for Korea, which is still on its way, these economies are now two-thirds to almost 90% based on services, whereas services only account for one-third of the Chinese economy.

Figure 4. Composition of gross value added (based on current prices), 1990 and 2002



Notes: Agriculture is composed of agriculture, hunting and forestry; and fishing (ISIC Rev. 3 01 to 05); industry consists of mining and quarrying; manufacturing; electricity, gas and water supply; and construction (ISIC Rev. 3 10 to 41); services are composed of wholesale and retail trade; hotels and restaurants; transport, storage and communications; financial intermediation; real estate, renting and business activities; public administration and defence; compulsory social security; education; health and social work; other community, social and personal service activities; private households with employed persons; and extra-territorial organisations and bodies (ISIC Rev. 3 50 to 99); composition of GDP instead of gross value added for China and the United States; 2001 instead of 2002 for Japan, the United States and Hong Kong, China.

Sources: OECD, National Accounts and Main Economic Indicators databases; Eurostat, NewCronos database; and OECD, based on national sources.

Technology- and knowledge-intensive industries

All industries generate and/or exploit new technology and knowledge to some extent, but some are more technology- and/or knowledge-intensive than others. To gauge the importance of technology and knowledge, it is useful to focus on the leading producers of high-technology goods and on the activities (including services) that are intensive users of high technology and/or have the relatively highly skilled workforce necessary to benefit fully from technological innovations. Box 2 sets out the OECD methodology for classifying industries according to their technology- or knowledge-intensity.

Box 2. Technology- and knowledge-intensive industries

On the basis of methodological work at the OECD, manufacturing industries are classified in four different categories of technological intensity*:* high technology, medium-high technology, medium-low technology and low technology. For reasons of availability of comparable statistics, this classification is based on indicators of (direct as well as indirect) technological intensity in OECD countries, which reflect to some degree “technology-producer” or “technology-user” aspects. These indicators are R&D expenditures divided by value added and R&D expenditures divided by production. This classification is particularly useful for analysing industry information on employment or value added by technological intensity, for example. To do likewise for international trade flows – which are defined at product level – requires attributing each product to a specific industry. However, not all products in a “high-technology industry” necessarily have a high technology content. Likewise, some products in industries with lesser technology intensities may well incorporate a high degree of technological sophistication. Because limited detailed data are available for services at present, industry and product classifications only concern the manufacturing industry.

The full list of industries classified by technology intensity is composed as follows:

High-technology industries	**ISIC Rev. 3**	**Medium-low-technology industries**	**ISIC Rev. 3**
Aircraft and spacecraft	353	Building and repairing of ships and boats	351
Pharmaceuticals	2423	Rubber and plastics products	25
Office, accounting and computing machinery	30	Coke, refined petroleum products and nuclear fuel	23
Radio, TV and communications equipment	32	Other non-metallic mineral products	26
Medical, precision and optical instruments	33	Basic metals and fabricated metal products	27-28
Medium-high-technology industries	**ISIC Rev. 3**	**Low-technology industries**	**ISIC Rev. 3**
Electrical machinery and apparatus, n.e.c.	31	Manufacturing, n.e.c.; Recycling	36-37
Motor vehicles, trailers and semi-trailers	34	Wood, pulp, paper, paper products,	
Chemicals excluding pharmaceuticals	24 excl. 2423	printing and publishing	20-22
Railroad and transport equipment, n.e.c.	352 + 359	Food products, beverages and tobacco	15-16
Machinery and equipment, n.e.c.	29	Textiles, textile products, leather and footwear	17-19

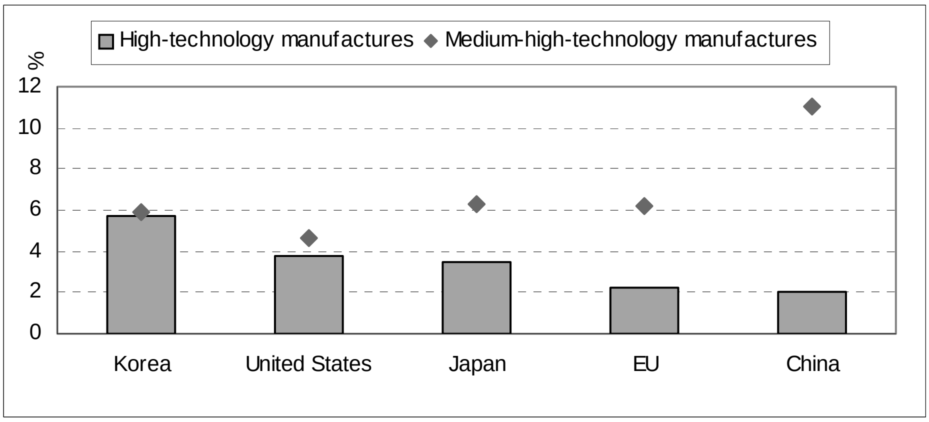
Based on previous analysis of users of embodied technology (based on input-output tables), recently available (though limited) R&D intensities for services sectors and a preliminary evaluation of the composition of workforce skills by activity, the following ISIC Rev. 3 “market” service activities are considered knowledge-intensive:

- Division 64: Post and telecommunications (these cannot be separated out for many countries).
- Divisions 65-67: Finance and insurance.
- Divisions 71-74: Business activities (not including real estate).

For China, more detailed data are available for the year 1997, which allow to examine in more depth the contribution of these technology- and knowledge-intensive industries to total value added.

In 1997, high-technology manufactures constituted only 2% of China’s gross value added, comparable with the EU, but below the shares for Japan, the United States and Korea, as can be seen in Figure 5. However, a substantial amount of China’s industrial output concerned medium-high-technology manufactures, which at 11% was considerably higher than that of the other economies. As China has been undergoing rapid economic development, it is quite possible that these shares have changed considerably since 1997. For the other economies, in most cases these shares were of similar magnitude in the year 2000, except for Korea, where the high-technology and the medium-high-technology shares both increased by one percentage point.

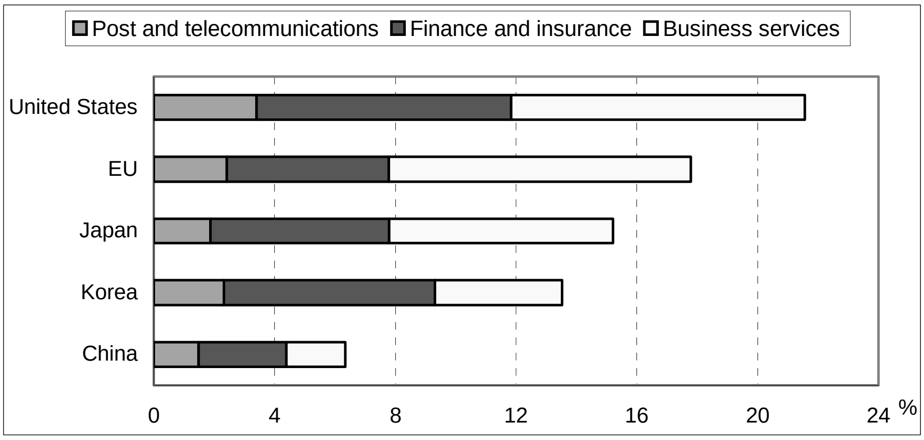
Figure 5. Value added for high- and medium-high technology manufactures as a % of gross value added, 1997 (based on current prices)



Source: OECD, STAN and National Accounts databases; and OECD, based on national sources.

Figure 6 shows that China's value added in knowledge-intensive market services was far behind that of the other economies, as could be expected after studying Figure 4. China's share was only 6.3% in 1997, significantly less than the other shares, which stood at between 13.5% for Korea and 21.6% for the United States. As before, the Chinese shares have probably changed since 1997. In 2000, the shares for the EU and the United States had increased by almost one percentage point, the Japanese share had increased by half a point, while in Korea there was a reduction of 0.7 point.

Figure 6. Share of total value added for knowledge-intensive "market" services, 1997 (based on current prices)



Source: OECD, STAN and National Accounts databases; and OECD, based on national sources.

INTERNATIONAL TRADE

Globalisation is a dynamic, multidimensional process. National economies can integrate their activities and internationalise through various channels, *e.g.* trade in goods and services, capital and labour flows, transfer of production facilities and/or technology. Even though such economic linkages are not new, the intensity and multiplicity of transactions have accelerated over the past decade, making the concept of "globalisation" elusive and its economic implications harder to quantify.

China is an important player in the globalisation process. The following section on trade in goods and services will show indicators that try to quantify to some extent this on-going process. Data relating to trade in goods and services correspond to each country's exports to, and imports from, the rest of the world. These data are collected to compile the balance of payments. Since data on trade in services are collected solely for use in compiling balances of payments, these have been chosen as source data to ensure that trade in goods and trade in services are comparable.

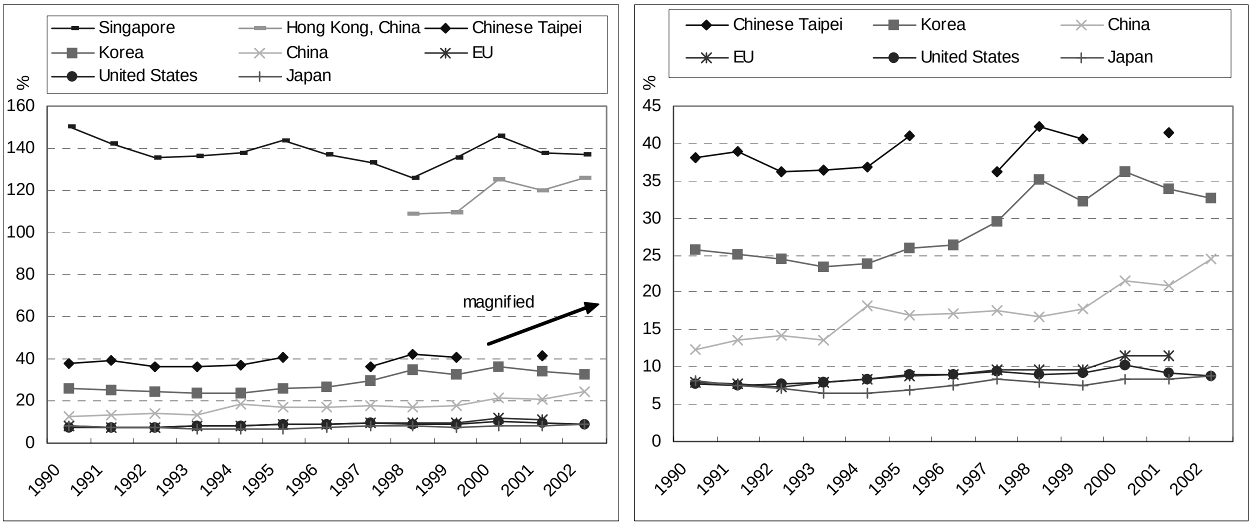
There is, however, the problem of valuation. Box 1 outlined the major considerations when comparing financial data for China with the other economies. The values that are used in this section are expressed in US dollars and relate to declared transaction values (imports c.i.f., exports f.o.b.). Trade conversion rates (source IMF and UNSD) are used to convert data from national currencies into US dollars. The exchange rates are the rates provided to the UNSD either by the country concerned or compiled by the IMF. Trade conversion factors are weighted averages of monthly or quarterly exchange rates, the weights being the corresponding monthly or quarterly values of imports and exports.

Trade-to-GDP ratio

The most frequently used indicator of the importance of international transactions relative to domestic transactions is the trade-to-GDP ratio, which is the average share of exports and imports of goods and services in GDP. International trade tends to be more important for countries that are small (in terms of size or population) and surrounded by neighbouring countries with open trade regimes than for large, relatively self-sufficient countries or those that are geographically isolated and thus penalised by high transport costs. Other factors also play a role and help explain differences in trade-to-GDP ratios across countries, such as history, culture, (trade) policy, the structure of the economy (especially the weight of non-tradable services in GDP), re-exports and the presence of multinational firms (intra-firm trade).

These considerations are borne out by the results in Figure 7, which depicts trade in goods-to-GDP ratios of more than 100% for the two small states, Singapore and Hong Kong, China. These economies are also often used as transit countries for exported goods. The figure further shows the opening up of the Chinese market during the 1990s. Chinese trade grew rapidly in importance, doubling from 12.2% of GDP in 1990 to 24.5% in 2002. In particular between 1999 and 2002, the ratio rose almost 7 percentage points. The trade-to-GDP ratios grew in the other economies as well, although at much more modest rates. Finally, the figure shows that China is much more dependent on trade than the United States, the EU and Japan.

Figure 7. Trade in goods as a share of GDP[1]



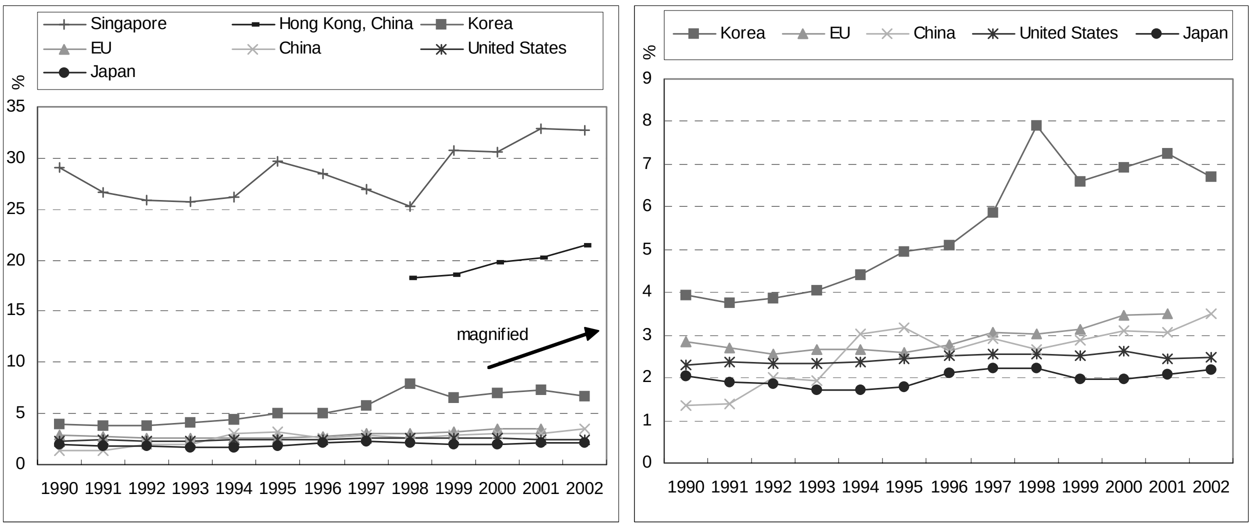
Notes: 1. Average of imports and exports as a share of nominal GDP.

Data for the EU exclude intra-EU trade.

Source: OECD, National Accounts and ITCS databases; IMF, Balance of Payments Statistics; and OECD, based on national sources.

Although the numbers are much smaller than for the previous indicator, the picture is not much different for trade in services (see Figure 8). Hong Kong, China and Singapore have far higher ratios than the other economies. Chinese trade in services has grown from 1.3% of GDP in 1990 to 3.5% in 2002, overtaking the United States and Japan in the process.

Figure 8. Trade in services as a share of GDP[1]



Notes: 1. Average of imports and exports as a share of nominal GDP.

Data for the EU exclude intra-EU trade.

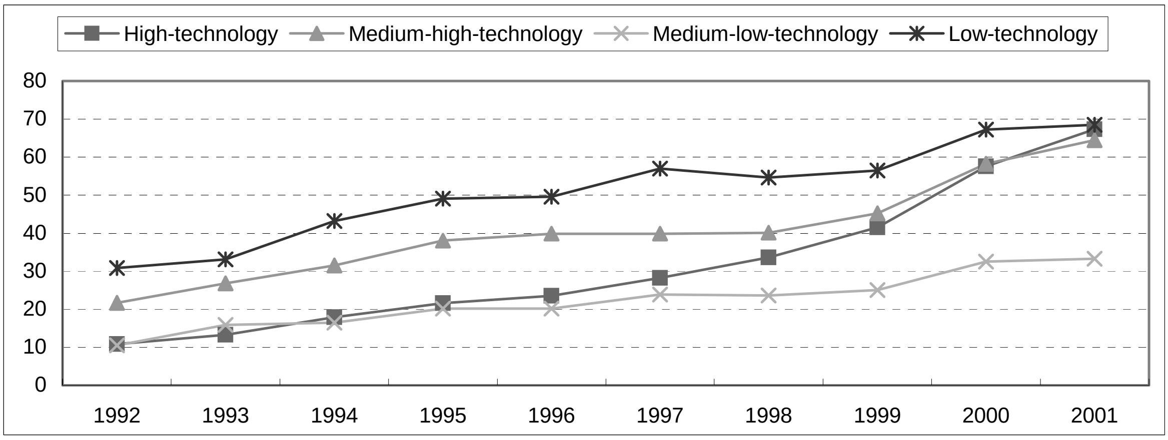
Source: OECD, National Accounts database; and IMF, Balance of Payments Statistics.

Trade in goods by technological intensity

It was mentioned before that some industries are more technology- and/or knowledge-intensive than others, and that it is useful to focus on the leading producers of high-technology goods and on the activities (including services) that are intensive users of high technology. Box 2 outlined the OECD methodology for breaking down industries by their technology intensity, while Figures 5 and 6 showed the contribution of technology- and knowledge-intensive industries to GDP in the studied economies. The next figures explore the role of technology- and knowledge-intensive industries in international trade.

Dissecting Chinese trade in goods – shown in Figure 9 – reveals that high-technology manufactures have caught up from being the least important category in 1992 (together with medium-low technology goods) to being the most important category in 2001 (together with low technology goods).

Figure 9. Evolution of Chinese trade by technological intensity, billions of USD in current prices[1]

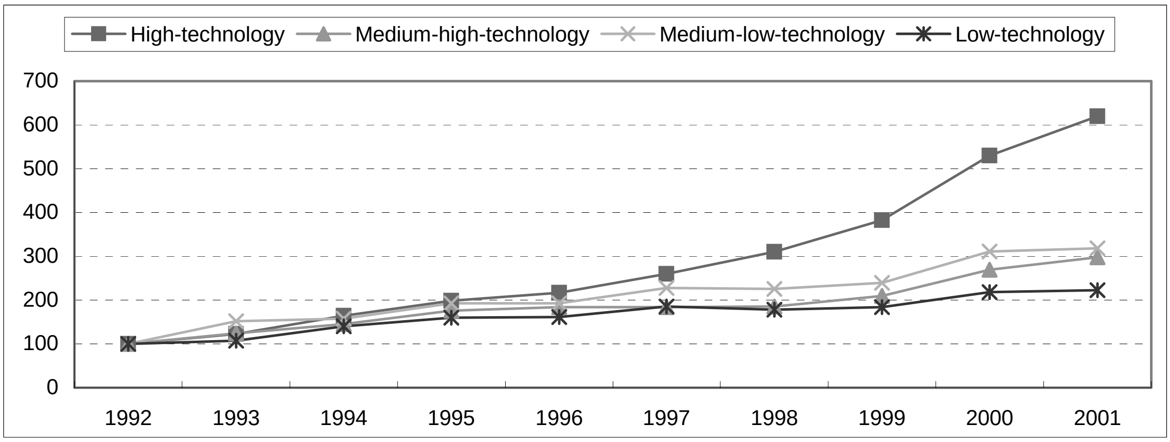


Note: (1) Average of imports and exports.

Source: OECD, ITCS database.

The increasing importance of high-technology trade is better seen by normalising the different categories to a common base, *in casu* 1992=100 (see Figure 10). This way, it can be seen that while trade in low-technology, medium-low technology and medium-high technology goods increased between two- and three-fold between 1992 and 2001, high-technology trade grew more than six-fold. The figure further shows that the largest share of the 7 percentage points growth in trade in goods between 1999 and 2002, which was observed in Figure 7, can be attributed to trade in high-technology manufactures.

Figure 10. Evolution of Chinese trade in goods by technological intensity, 1992=100[1]



Note: (1) Average of imports and exports.

Source: OECD, ITCS database.

The two previous figures looked at total trade, by taking the average of imports and exports. Figure 11 shows that imports and exports have grown at the same pace. Imports of high-technology manufactured goods increased from USD 12 billion in 1992 to USD 70 billion in 2001, while exports grew from USD 9 billion to USD 64 billion. Part of this growth can be ascribed to intra-firm trade of multinationals. For example, intra-firm exports from the United States to China grew from USD 0.3 billion in 1994 to USD 2 billion in 2000, while intra-firm imports by US multinationals from China grew from USD 0.4 billion to USD 2.3 billion during the same period.

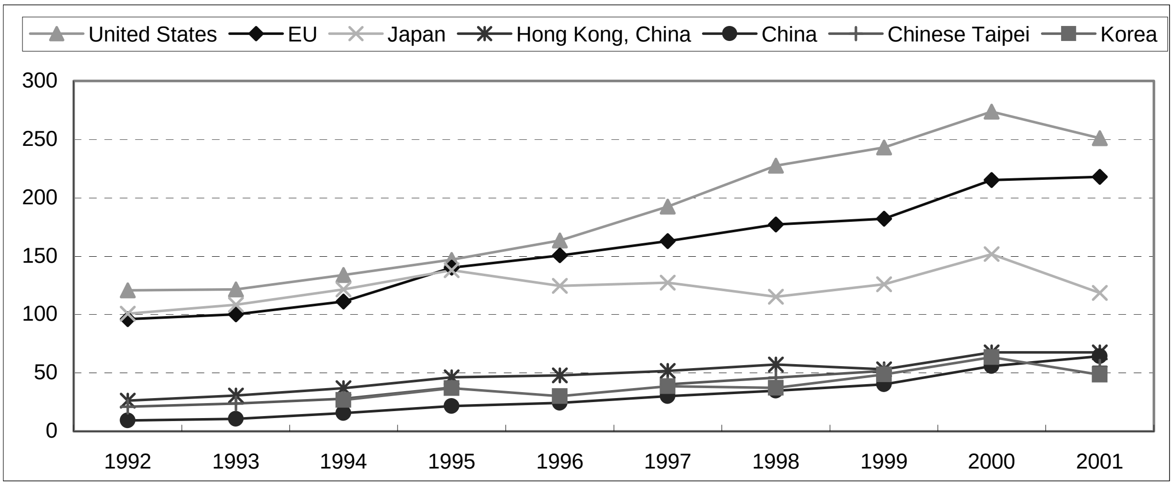
Figure 11. Evolution of high-technology manufacturing trade for China, billions of USD in current prices

Source: OECD, ITCS database.

Chinese exports of high-tech manufactured goods in 2000 and 2001 were at a comparable level with the high-tech exports of Chinese Taipei, Korea and Hong Kong, China, with exports worth between USD 48 and USD 67 billion. Japanese exports stood at USD 118 billion in 2001, decreasing from a high of USD 152 billion in 2000. EU exports were over USD 200 billion, while US exports reached more than USD 250 billion (see Figure 12).

However, while five of the other economies saw their level of exports increase 2 to 2.6 times between 1992 and 2001, Chinese exports of high-technology manufactures increased seven-fold, increasing its share in the world total of high-technology exports from under 2% to over 5%. At the same time, Japanese exports of high-tech goods only marginally increased throughout the 1990s and early 2000s. As a result, Chinese exports of high-technology goods, which amounted to less than 10% of the levels in the United States, the EU and Japan in 1992, were equivalent to between a third and a quarter of the levels in the United States and the EU in the beginning of the new millennium and to more than half of the level in Japan.

Figure 12. Evolution of high-technology manufacturing exports, billions of USD in current prices



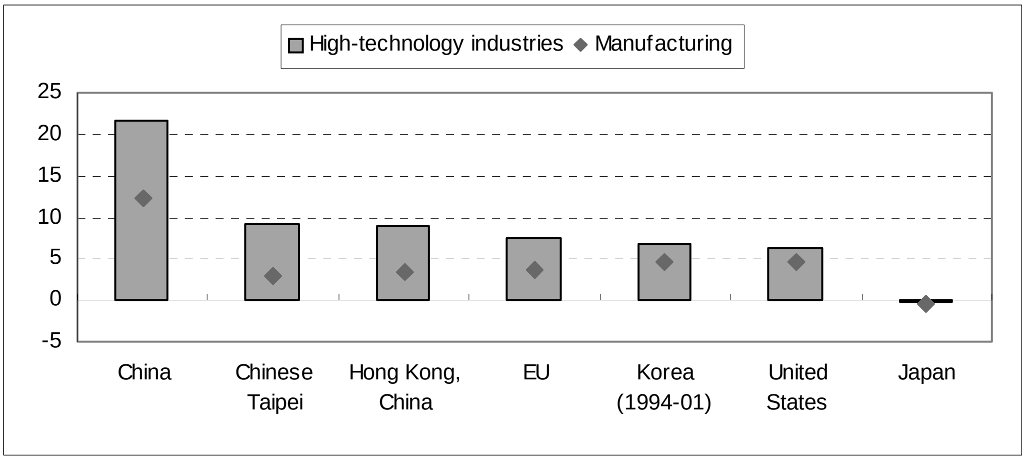
Note: EU data exclude intra-EU trade.

Source: OECD, STAN and ITCS databases.

Comparing the annual average growth rates[1] of high-technology manufacturing relative to the growth rates of total manufacturing, Figure 13 reiterates that China has gone through a period of rapid catch-up. The figure demonstrates the high growth rate of Chinese high-technology exports over the period 1992-2001 (21.7% annually) and the low growth rate of Japan (-0.2%). The other economies are closely knit together with growth rates between 6.4% and 9.1%.

1. To avoid showing growth rates in nominal terms, and for the sake of consistency with other growth rates used in this document, data have been deflated, in this case using the US implicit GDP deflator. It needs to be kept in mind, though, that using one specific deflator for all economies is of limited value, since it scales all the results by the same index. Furthermore, it relies on the assumption that high-technology exports have had the same change in prices as GDP, which is unlikely to have been the case.

Figure 13. Growth of high-technology exports, annual average growth rate 1992-2001 (based on data in constant 1995 USD)

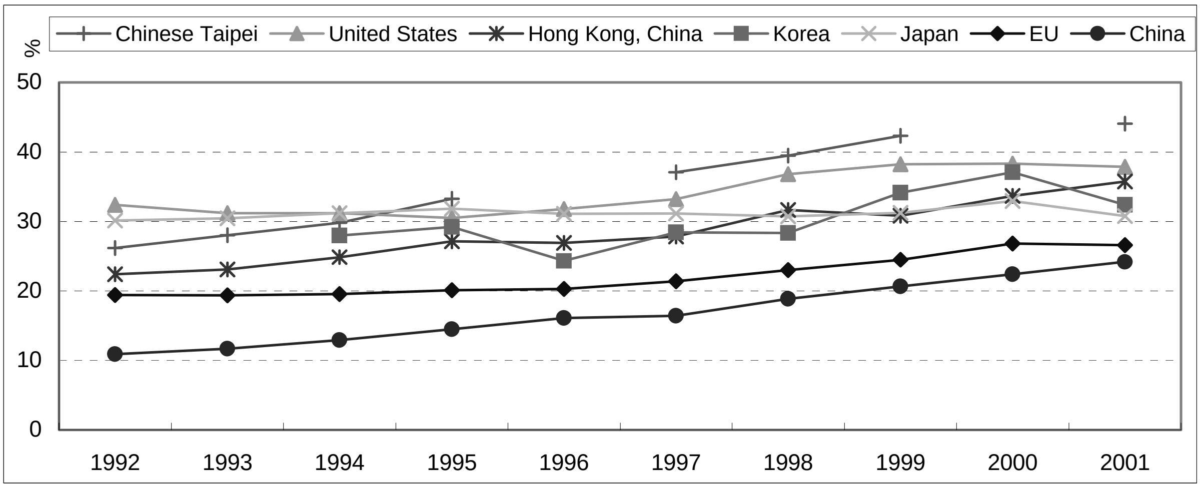


Note: EU data exclude intra-EU trade; data deflated from current into constant USD with the US implicit GDP deflator.

Source: OECD, STAN and ITCS databases.

The previous figure showed that in all studied economies, high-technology exports have grown faster than total manufacturing, meaning a growing share of high-tech goods in total manufacturing. This is illustrated by Figure 14, which reveals that high-technology goods accounted for 24.2% of Chinese exports in goods in 2001, up from 10.9% in 1992, considerably closing the gap with the other economies.

Figure 14. High-technology exports as a percentage of total manufactured exports (based on data in current USD)



Note: EU data exclude intra-EU trade.

Source: OECD, STAN and ITCS databases.

Revealed comparative advantage by technology intensity

An assessment of countries' strengths and weaknesses in terms of technological intensity must not focus solely on exports, but must also gauge the role of imports, as exports may depend heavily on imports in the same industry. Indicators of revealed comparative advantage allow for a better understanding of countries' specialisation profiles. Such indicators are based on the contribution of different industries to the trade balance (see Box 3).

Box 3. Contribution to the trade balance

The "contribution to the trade balance" makes it possible to identify an economy's structural strengths and weaknesses via the composition of international trade flows. It takes into account not only exports, but also imports, and tries to eliminate business cycle variations by comparing an industry's trade balance with the overall trade balance. It can be interpreted as an indicator of "revealed comparative advantage", as it indicates whether an industry performs relatively better or worse than the manufacturing total, whether the manufacturing total itself is in deficit or surplus.

If there were no comparative advantage or disadvantage for any industry *i*, a country's total trade balance (surplus or deficit) should be distributed across industries according to their share in total trade. The "contribution to the trade balance" is the difference between the actual and this theoretical balance:

$$(X_i - M_i) - (X - M)\frac{(X_i + M_i)}{(X + M)}$$

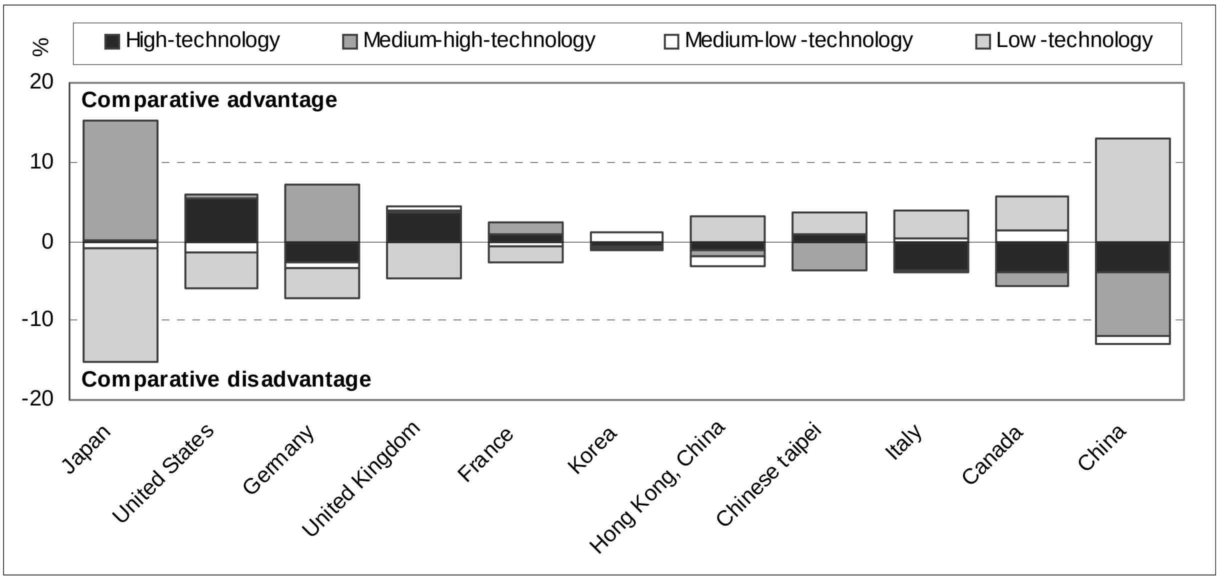
where $(X_i - M_i)$ = observed industry trade balance,

and $(X - M)\frac{(X_i + M_i)}{(X + M)}$ = theoretical trade balance.

A positive value for an industry indicates a structural surplus and a negative one a structural deficit. The indicator is additive and individual industries can be grouped together by summing their respective values: by construction, the sum over all industries is zero. To allow comparisons across industries, the indicator is generally expressed as a percentage of total trade or of GDP.

Interestingly, despite the surge in exports of high-technology goods, China still has a strong comparative advantage in low-technology industries (see Figure 15). The structural surplus in these industries accounted for 13% of total manufacturing trade in 2001. The other industries reported a structural deficit, with medium-low-technology industries accounting for 1.1%, high-technology industries for 3.9% and medium-high-technology industries for 8.0%.

Figure 15. Contribution to the manufacturing trade balance, as a percentage of manufacturing trade, 2001 (based on data in current USD)

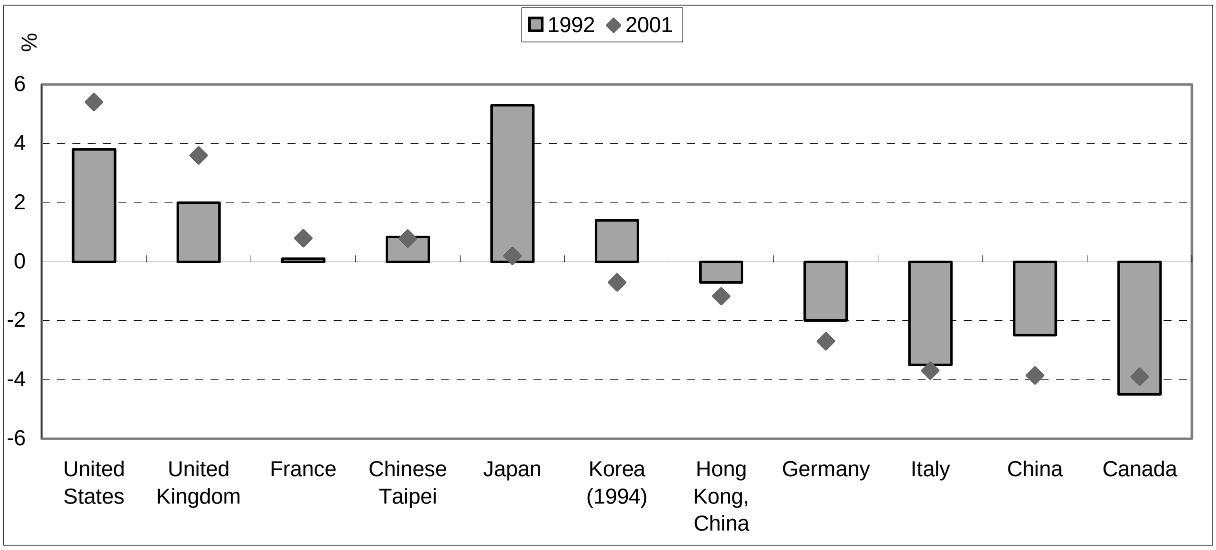


Note: EU data exclude intra-EU trade.

Source: OECD, STAN and ITCS databases.

For most economies, specialisation in high-technology has changed little over the past decade (see Figure 16). There are exceptions, however. Japan's comparative advantage in high-technology industries declined drastically over the 1990s, whereas those of the United Kingdom and of the United States increased markedly. Korea went from an advantage to a disadvantage and the Chinese comparative disadvantage actually increased during the past decade.

Figure 16. Contribution of high-technology industries to the manufacturing trade balance in 1992 and 2001, as a percentage of total manufacturing trade (based on data in current USD)



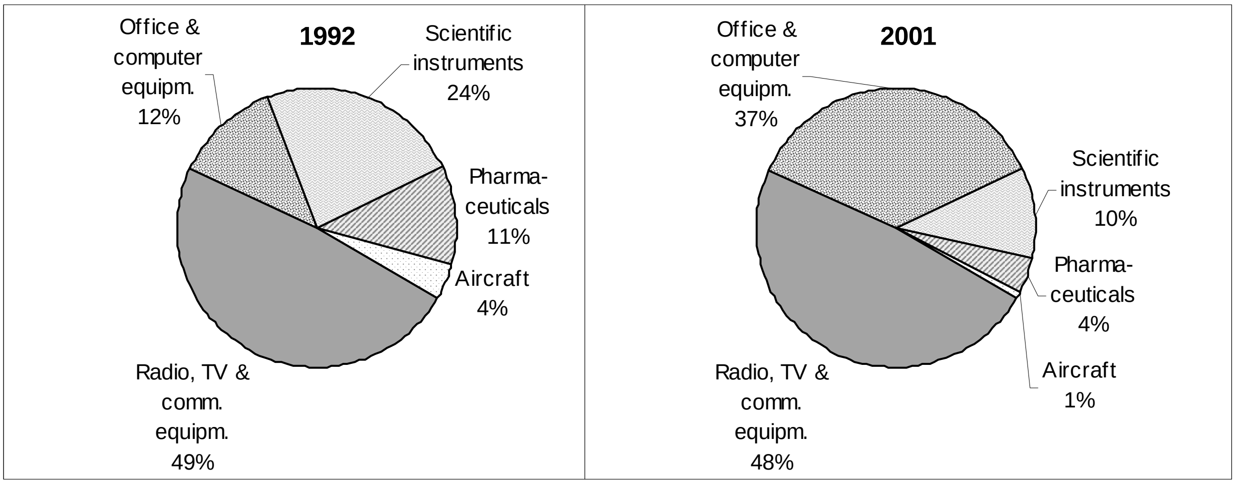
Note: EU data exclude intra-EU trade.

Source: OECD, STAN and ITCS databases.

Composition of high-technology trade

In 2001, as in 1992, almost half of Chinese high-technology exports consisted of radio, TV and communications equipment, as can be seen in Figure 17. More than one-third of high-technology exports was made up by office and computer equipment, up from 12.2% in 1992. Exports of office and computer equipment surged from USD 1.1 billion in 1992 to USD 23.6 billion in 2001, an increase of more than 2 000%. As a result, the other three categories of high-tech industries saw their shares decline, despite considerably higher exports in 2001 than in 1992.

Figure 17. Composition of Chinese high-technology exports, 1992 and 2001



Source: OECD, ITCS database.

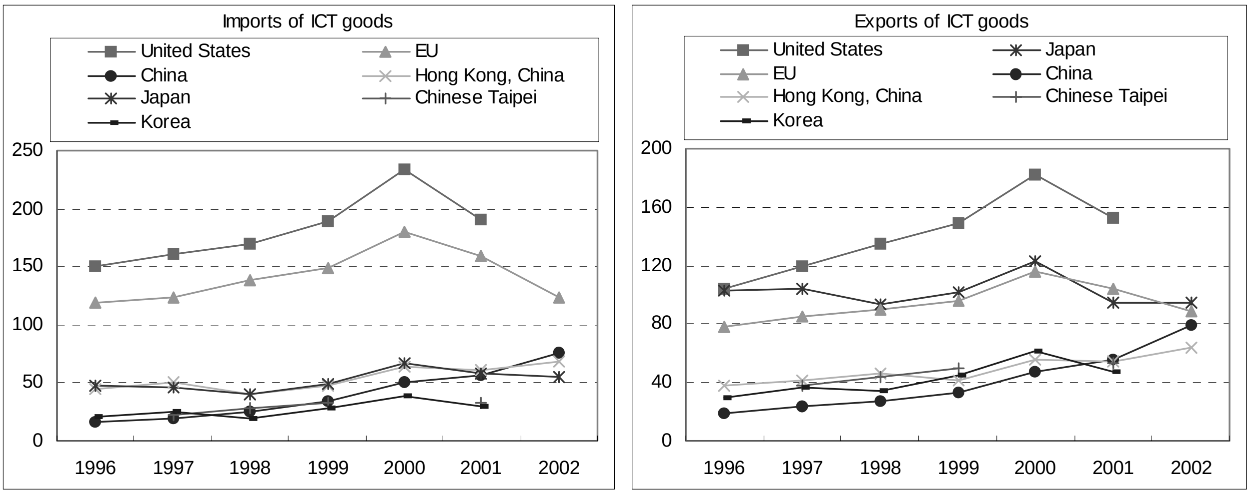
Trade in ICT goods

Clearly, a large part of the high-technology industries are producers of ICT goods, in particular the two aforementioned industries that accounted for three-quarters of Chinese high-tech exports in 2001. This section focuses on ICT goods alone. So far, data shown were commodity data according to the Harmonised System (HS) Rev. 1, allocated to industries according to ISIC Rev. 3, using a standard conversion key. For ICT goods, we can use a classification of ICT goods based on the HS, which was recently developed by the OECD member countries through their Working Party on Indicators for the Information Society (WPIIS). The ICT commodities definitions consist of a list of six-digit HS categories, grouped into the following broad categories: telecommunications equipment, computer and related equipment, electronic components, audio and video equipment, other ICT goods.

The left-hand graph of Figure 18 shows imports of ICT goods. These were highest in the United States, reaching USD 190 billion in 2001. The EU exports of ICT goods have been declining since 2000, recording USD 124 billion of ICT imports in 2002. China's imports of ICT goods, on the other hand, have been increasing steadily, amounting to USD 76 billion in 2002.

For exports – shown in the right-hand graph of Figure 18 – a similar picture emerges. The United States exported USD 152 billion worth of ICT goods in 2001, ahead of Japan (USD 95 billion in 2002) and the EU (USD 88 billion). China's exports are growing rapidly and are – at USD 79 billion in 2002 – approaching the EU and Japanese level.

Figure 18. Imports and exports of ICT goods, billions of USD in current prices

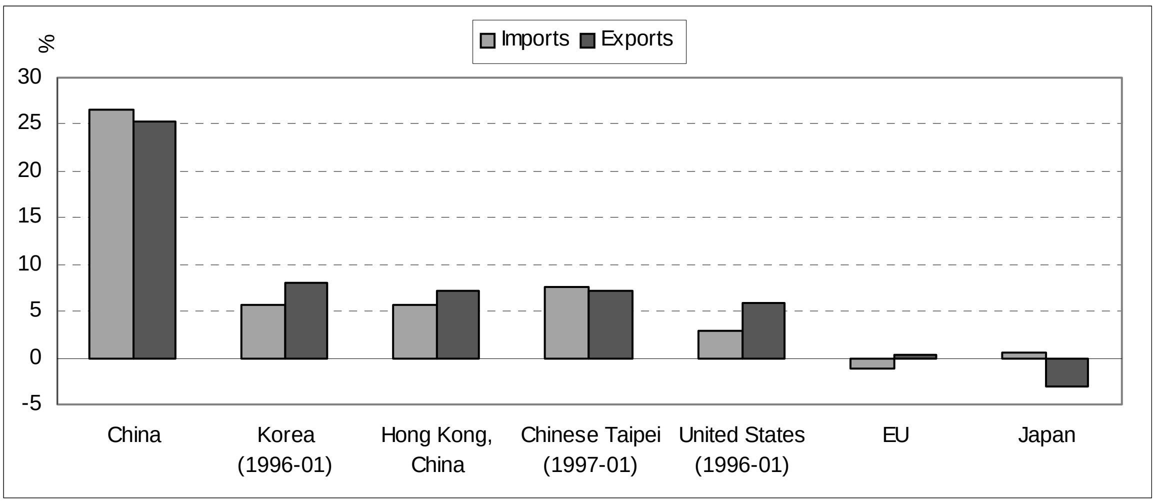


Note: Data for the EU exclude intra-EU trade; data for the EU for 2002 exclude data for the Netherlands.

Source: OECD, ITCS database.

Between 1996 and 2002, Chinese imports of ICT goods grew on average by 26.5% per annum and exports by 25.1%, as shown by Figure 19. The figure also clearly shows the lagging performance of the EU and Japan.

Figure 19. Trade in ICT goods, annual average growth rate 1996-2002 (based on data in constant 1995 USD)



Note: Data for the EU exclude intra-EU trade; data for the EU for 2002 exclude data for the Netherlands; data deflated from current into constant USD with the US implicit GDP deflator[2].

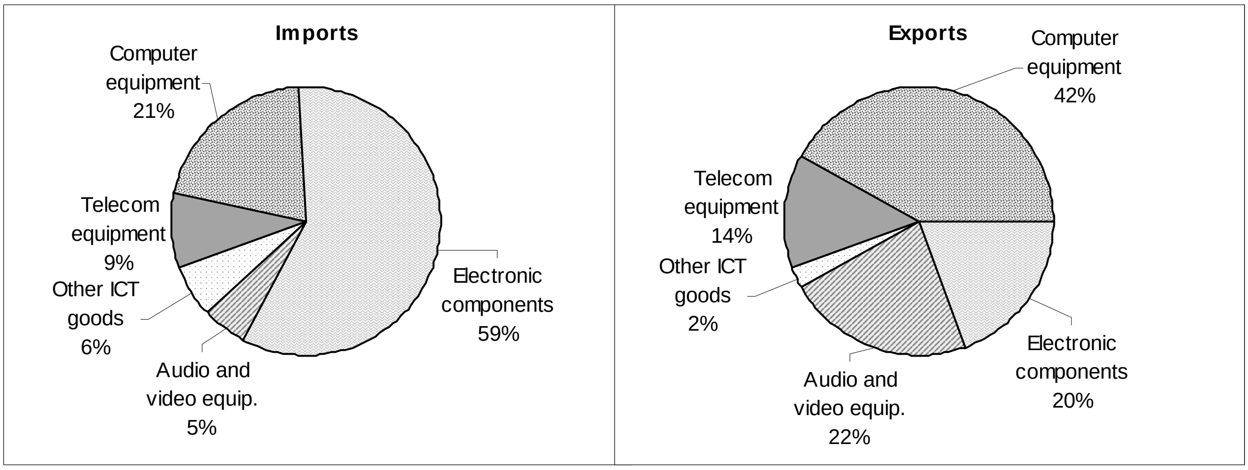
Source: OECD, ITCS database.

Looking at the breakdown into categories of ICT goods, Figure 20 reveals that 59% of Chinese imports in 2002 were electronic components, whereas more than three-quarters of exports consisted of computer, telecommunications, audio and video equipment. An interpretation could be that China imports the components of high-technology products for assembly in China, after which the final products are

2. See Footnote 1. for a justification and a criticism of using the US implicit GDP deflator.

assembled and exported back to the rest of the world. Multinational companies with affiliates in China may play a role in this as well.

Figure 20. Composition of Chinese trade in ICT goods, 2002



Source: OECD, ITCS database.

China's trade partners

When identifying the most important countries to which China exports its manufactured goods, the problem of transhipments becomes apparent (see Box 4). The reported data uncover that Hong Kong, China is the most important trading partner for Chinese manufacturing exports, accounting for 48% of exports in 1992, 26% in 1993 and 18% in 2001.

Box 4. Mirror statistics and transhipments

Trade statistics have some weak points. Trade data are never complete. Smuggling and non-reporting represent a serious problem in a number of countries. In addition, trade statistics - as any source of information - are not free of mistakes and omissions. Most countries include re-exports in their export and import statistics.

Mirror statistics are another source of problems. Theoretically, export statistics from one country to its partner countries should match the import statistics from these partner countries, an approach referred to as mirror statistics. Mirror statistics have a certain number of problems. One is the problem of transhipments, which can hide the actual source of supply. It is often difficult to assess the origin and the final destination for goods that transit through one or even more countries. A famous case is Hong Kong, China, which functions as a major “international marketing centre” for China, re-exporting its imports from China with an average margin of around 30%. Chinese producers are often not aware of the final destination of the products.

Another problem is that mirror statistics invert the reporting standards by valuing exports in c.i.f. terms (*i.e.* including transport cost and insurance) and imports in f.o.b. terms (excluding these items). An approximate match of trade statistics and their mirror statistics is a good sign of data reliability. Import figures should be slightly higher than export figures, as they include freight and insurance costs, although these costs obviously vary between products. An average difference of about 10% between import and export figures is the norm. However, discrepancies can occur for many reasons, such as coverage and time of recording, trade system used, commodity classification, valuation, quantity measurement, partner country and errors and estimations.

When analysing the trade data for China, the mirror statistics problem turns out to be very relevant, probably due to the transhipments problem. Table 1 lists mirror statistics in total manufacturing trade for China and for Hong Kong, China with a few selected partner countries. It is clear that either China underestimates their exports to the partner countries, or that these partner countries overestimate their manufacturing imports from China. The reverse is the case for Hong Kong, China. Furthermore, the observed difference of China with any partner country is comparable to the observed difference of Hong Kong, China with that partner country. This indeed points to the possible explanation that Hong Kong, China is used as a transhipment centre, and that countries, whether they be the sending or the receiving countries, have difficulties identifying the correct partner country.

Table 1. Total manufacturing trade, billions of USD

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
China exports to the US	7.9	16.3	20.9	24.1	26.0	32.0	37.4	41.6	51.4	53.8
US imports from China	26.2	32.8	40.3	47.3	53.0	61.0	73.5	80.2	97.8	100.1
China - US difference	*-18.4*	*-16.5*	*-19.4*	*-23.2*	*-27.0*	*-29.0*	*-36.1*	*-38.6*	*-46.4*	*-46.3*
Hong Kong, China exports to the US	27.4	30.9	34.9	37.5	38.1	40.7	..	41.2	46.8	42.2
US imports from Hong Kong, China	9.8	9.5	9.6	10.2	9.7	9.7	10.3	9.8	10.6	8.9
Hong Kong, China - US difference	*17.5*	*21.5*	*25.3*	*27.3*	*28.4*	*31.0*	*..*	*31.4*	*36.2*	*33.3*
China - Japan difference	*-4.6*	*-4.0*	*-5.0*	*-6.7*	*-8.6*	*-8.9*	*-6.7*	*-9.3*	*-12.1*	*-11.8*
Hong Kong, China - Japan difference	*4.3*	*5.1*	*6.4*	*8.0*	*9.5*	*9.4*	*..*	*7.8*	*9.7*	*10.0*
China - EU difference				*-15.8*	*-19.1*	*-19.7*	*-20.0*	*-24.1*	*-22.2*	
Hong Kong, China - EU difference				*16.1*	*17.2*	*17.6*	*..*	*16.1*	*13.8*	
China exports to Hong Kong, China	36.1	20.9	30.7	34.0	31.4	41.9	37.2	35.3	42.9	44.9
Hong Kong, China imports from China	44.1	50.4	58.8	67.5	71.5	76.3	..	76.3	89.9	85.5
China - Hong Kong, China difference	*-7.9*	*-29.6*	*-28.1*	*-33.4*	*-40.1*	*-34.4*	*..*	*-40.9*	*-47.0*	*-40.7*

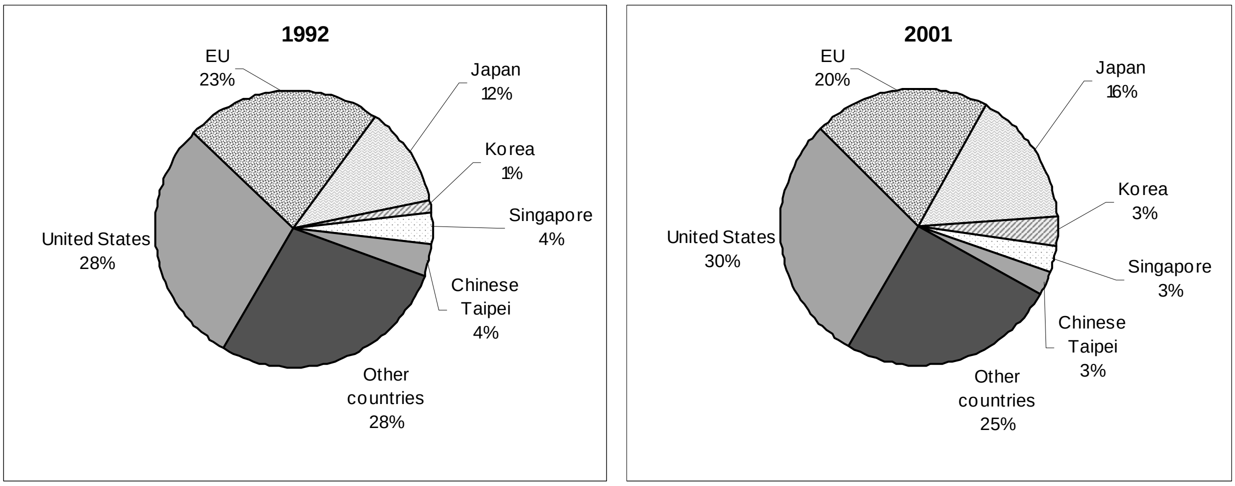
Source: OECD, ITCS database.

In a methodological note from the Chinese Custom’s office – dating back to 1994 – it is noted that: “the country of final destination refers to the country where the goods are to be consumed or further processed as known at the time of exportation. In instance where the country of final destination can not be ascertained, the exports will be credited to the final country dispatched to as known at the time of exportation.”

Since it is rather unlikely that all these exports were destined for the Hong Kong, China market, it appears that most of these goods were shipped onwards to the real destination. Therefore, to give a better picture of the real export partners of China, exports of China and Hong Kong, China have been taken together, after netting out trade between China and Hong Kong, China.

Figure 21 shows that the United States was the most important destination country, accounting for 30% of manufacturing exports from China and Hong Kong, China in 2001, moderately up from 28% in 1992. The EU and Japan followed at rank 2 and 3, with Japan gaining in importance over the last 9 years, its export share rising from 12% to 16%.

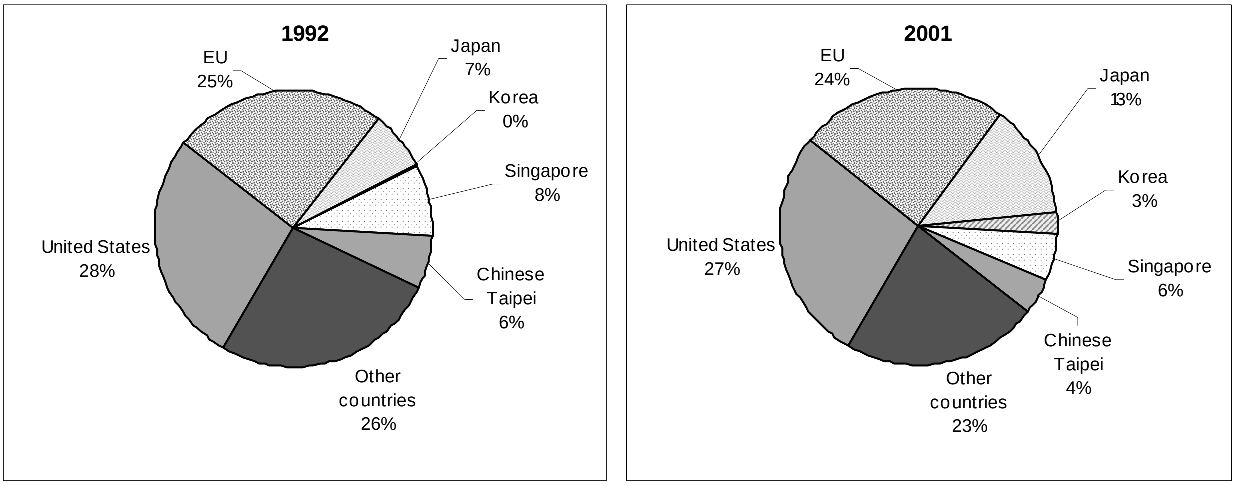
Figure 21. Destination of manufacturing exports of China and Hong Kong, China, 1992 and 2001



Source: OECD, ITCS database.

Concerning high-technology exports, the situation for the three big economic zones is the same as for total manufacturing (see Figure 22). Noteworthy are the larger shares of Singapore and Chinese Taipei, when compared with manufacturing.

Figure 22. Destination of high-technology manufacturing exports of China and Hong Kong, China, 1992 and 2001



Source: OECD, ITCS database.

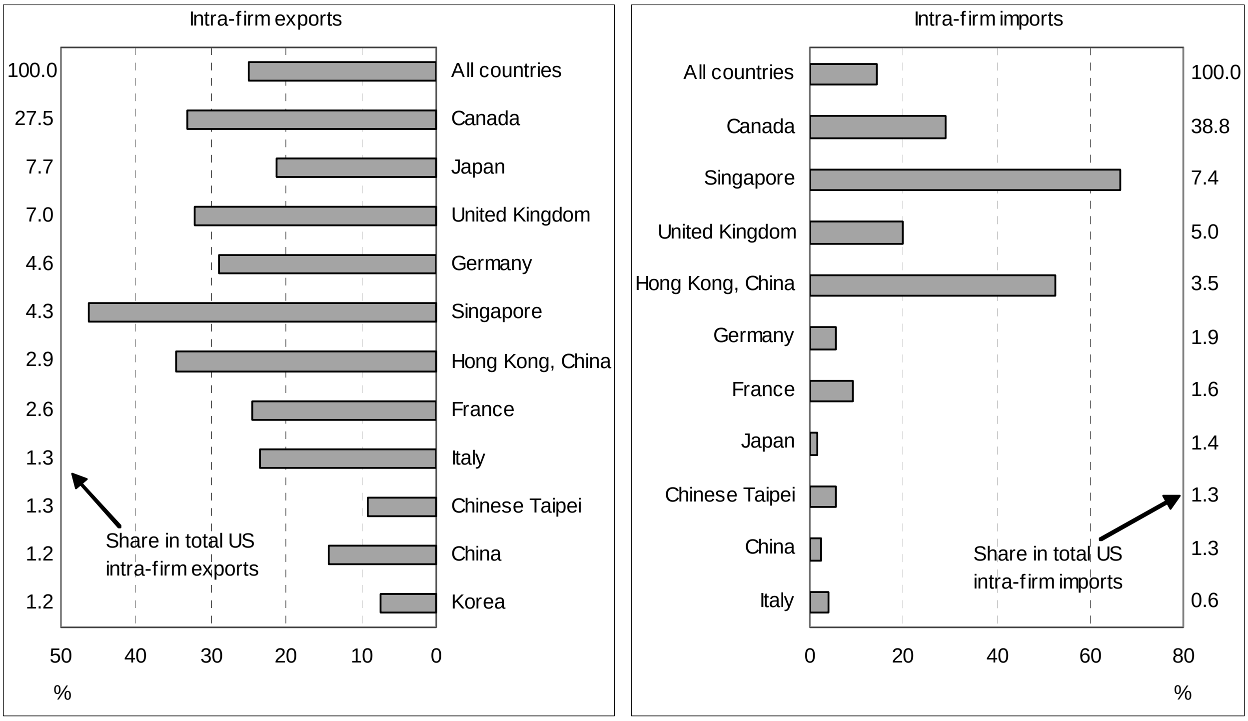
Intra-firm trade

Intra-firm trade is trade between enterprises belonging to the same group, but located in different countries. The ratio of intra-firm trade to total trade in countries that publish the relevant data is quite high. Once foreign investments have been made, these transactions reflect centralised decisions made as part of a multinational enterprise's global strategy. A significant portion of intra-firm trade may reflect the fact that affiliates have a better understanding of local market demand. Parent corporations and other firms in the group often prefer to export to their own affiliates, which then sell the goods as received to local consumers. In fact, parent corporations could sell these products directly to local distributors, without involving their affiliates. It is difficult to determine whether such transactions would be less numerous if they did not go through their affiliates.

The indicator shown in Figure 23 is for intra-firm exports and imports between US parent companies and their foreign affiliates in relation to aggregate US trade, the United States being the only country for which sufficient detail is available. Overall, these ratios amount to 25% for exports and 15% for imports. Figure 23 shows that for exports, the ratio of intra-firm trade of US parent companies is highest with Singapore (46.4%) and Hong Kong, China (34.5%). For imports it is highest with Singapore (66.4%) and Hong Kong, China (52.4%) as well. For China, the export ratio stood at 14.3% in 2000, while the import ratio reached only 2.3%.

It should be borne in mind that ratios of intra-firm trade with partner countries, even if they attain substantial values, may account for only a small percentage of overall intra-firm trade. For example, intra-firm imports from Canada account for less than 30% of aggregate US imports from Canada, as opposed to more than 65% in the case of Singapore. However, in absolute value they account for nearly 39% of total US intra-firm imports *(i.e.* double the share for Europe) but scarcely 7.5% in the case of Singapore.

Figure 23. US intra-firm exports of goods in total exports of goods to partner country, 2000 (left) and US intra-firm imports of goods in total imports of goods to partner country, 2000 (right)



Source: OECD, AFA and ITCS databases.

FOREIGN INVESTMENT

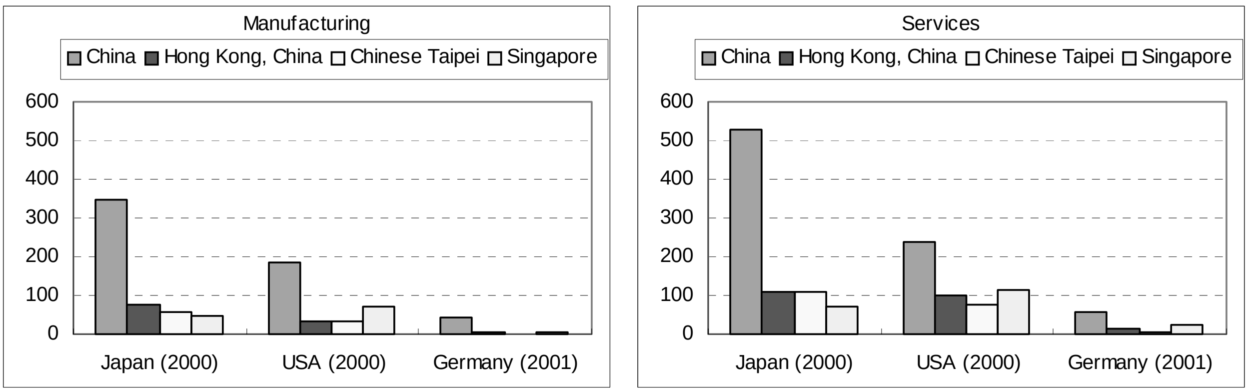
With this last indicator we have entered the area of foreign affiliates. The criterion of possession of 10% of a company's voting shares or voting power is deemed to indicate the existence of a direct investment relationship and of *influence* over the management of the firm in question. In contrast, *control* implies the ability to shape a company's activities. This entails ownership of a majority of ordinary shares (more than 50%) or voting power on the board of directors. Variables such as turnover, number of employees or exports are attributed in full to the investor that controls the company. The term "foreign affiliate" is restricted to foreign affiliates that are majority-owned. Accordingly, the geographical origin of a foreign affiliate is defined as the country of the parent company if it holds, directly or indirectly, more than 50% of the affiliate's voting shares. However, the majority holding criterion is not used for the United States, since minority foreign-owned firms are also included in their statistics.

Foreign affiliates in manufacturing and services

In the OECD databases, information on foreign affiliates located in China is available only for a limited number of countries. There are two separate data collections, one for foreign affiliates in the manufacturing sector and one for foreign affiliates active in the services sector. For three reporting countries, Germany, Japan and the United States, data are available for outward investment in China in both the manufacturing and the services sector.

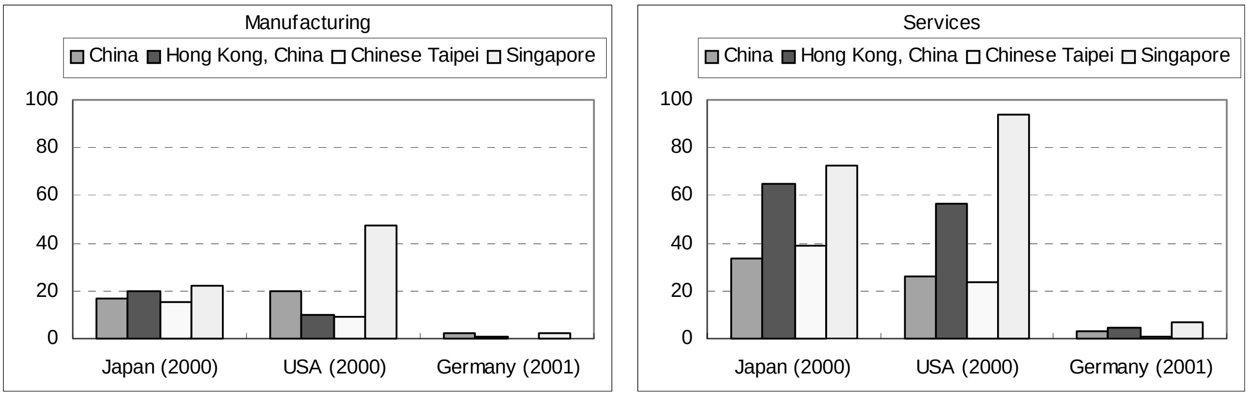
Figures 24 and 25 reveal that German affiliates play a minor role compared with Japanese and US affiliates. They also show that Chinese affiliates employ the highest number of employees in the four Asian countries for which these data are depicted, while affiliates located in Singapore generated the highest turnover. Furthermore, foreign affiliates in services employ more people than foreign affiliates in manufacturing, and generally generate more turnover.

Figure 24. Number of employees of affiliates under foreign control in manufacturing and services in selected Asian economies, controlled by Japan, the United States and Germany, 1000s



Source: OECD, AFA and FATS databases.

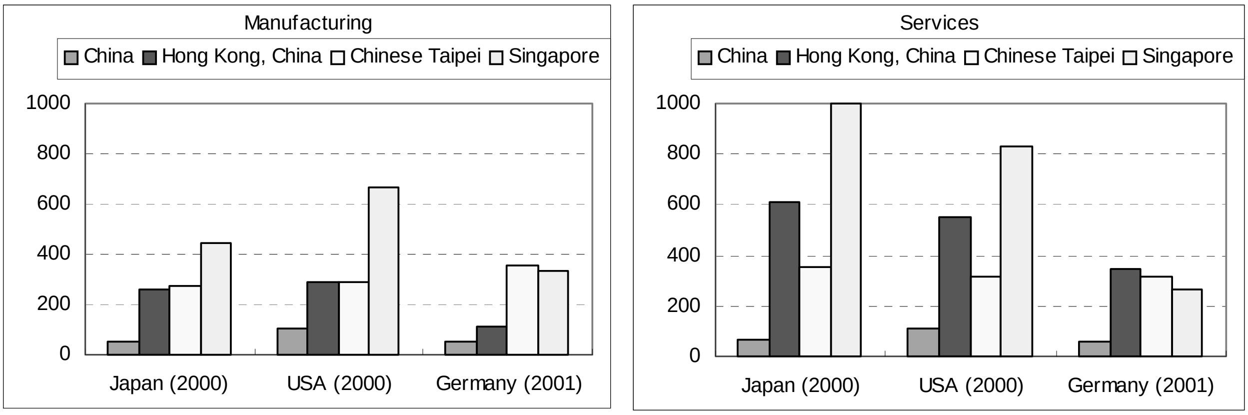
Figure 25. Turnover of affiliates under foreign control in manufacturing and services in selected Asian economies, controlled by Japan, the United States and Germany, billions of USD



Source: OECD, AFA and FATS databases.

Figure 26 reports the turnover per employee generated in foreign controlled affiliates. This figure illustrates the very low turnover of Chinese affiliates for all three reporting countries, and the high turnover of Singaporean affiliates in the case of Japan and the United States as reporting countries. This could indicate that multinationals are using China more for the production of labour-intensive than for capital-intensive goods and services.

Figure 26. Turnover per employee of affiliates under foreign control in manufacturing and services in selected Asian economies, controlled by Japan, the United States and Germany, 1000s of USD



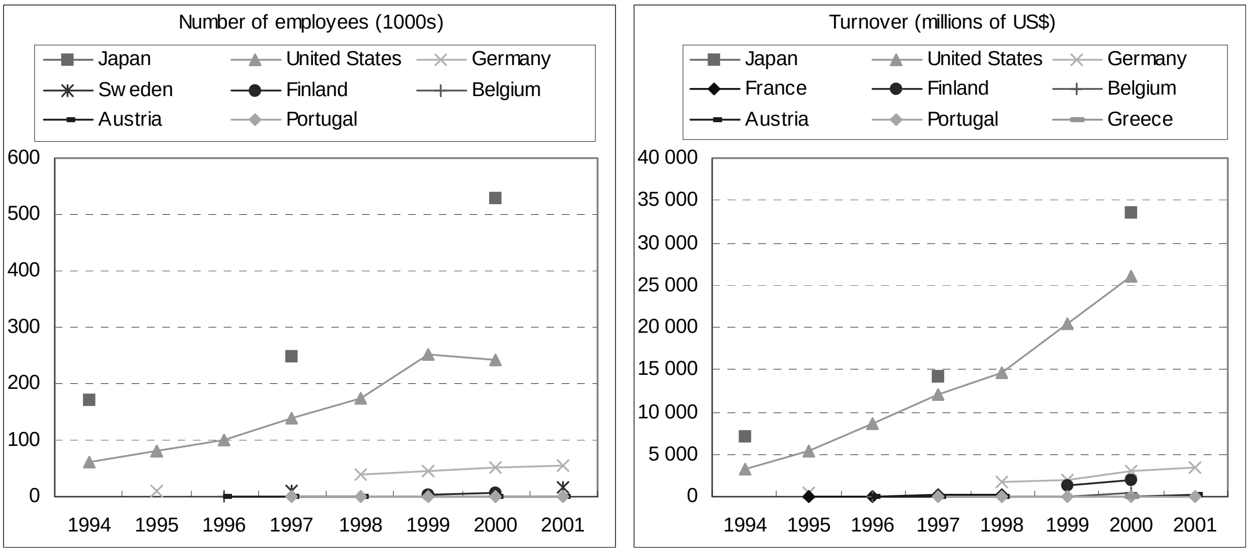
Source: OECD, AFA and FATS databases.

Affiliates under foreign control in services in China

For outward investment of OECD countries in China, in the case of the services sector, data are available for some OECD countries.

The main message of Figure 27 is that employment and turnover of foreign affiliates has been rising steadily since 1994 – for those reporting countries for which data are available – and that Japan and the United States are the two main investing countries, followed at some distance by Germany.

Figure 27. Number of employees and turnover of affiliates under foreign control in the services sector in China



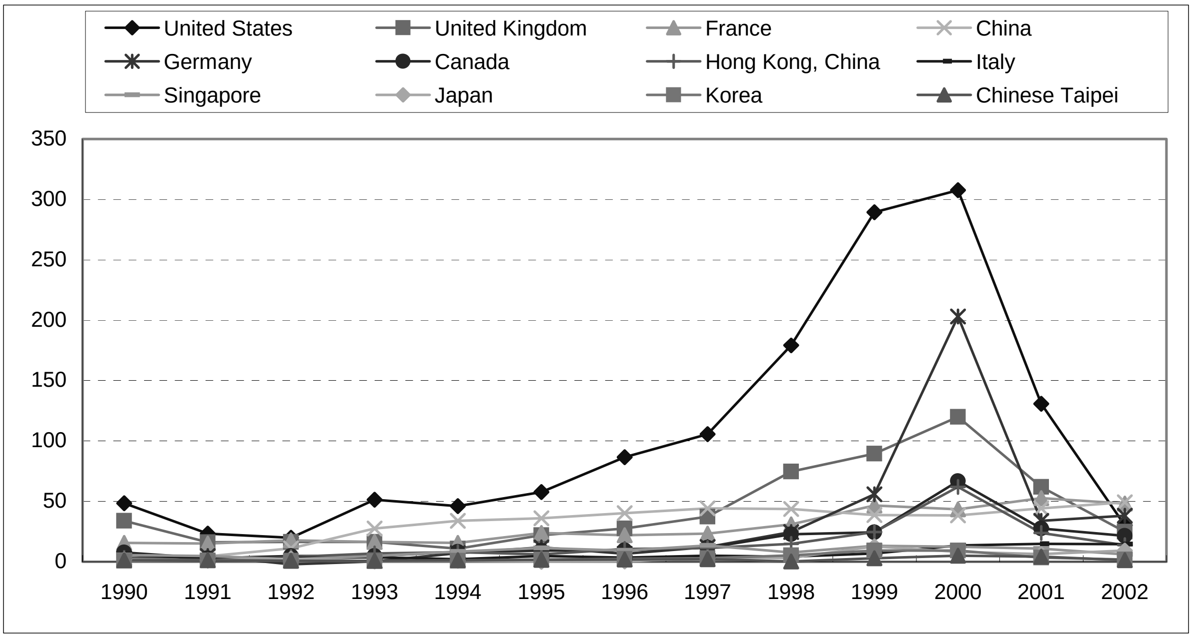
Source: OECD, FATS database.

Foreign Direct Investment

Whereas for an enterprise to be recorded as an affiliate under foreign control requires ownership of a majority of ordinary shares (more than 50%) or voting power on the board of directors, a foreign investment is classified as a direct investment if the foreign investor holds at least 10% of the ordinary shares or voting power in an enterprise and exerts some influence over its management. Any investment amounting to less than 10% of ordinary shares is posted as portfolio investment. Direct investment is measured in terms of flows and stocks. Direct investment flows, whether inward or outward, comprise investors' equity capital (claims and liabilities), net reinvested earnings and other capital (such as loans).

Inflows of FDI into China have been notable (Figure 28). According to IMF data they stood at almost USD 49.3 billion in 2002 – their highest level ever – making China the world's largest recipient of FDI in 2002 (at least when the notoriously volatile data for Luxembourg are disregarded). Judging from preliminary data for the first four months of 2003, significant further increases are likely for 2003. Among the other non-OECD countries, Hong Kong, China is another major recipient of FDI flows (albeit often in connection with investment projects in mainland China), which however saw its inflows drop sharply, from USD 61.9 billion in 2000 to USD 13.7 billion in 2002. It is interesting to note that while in most countries a sharp drop was registered after the frenzy of the year 2000, in China there was no decrease in FDI inflows.

Figure 28. FDI inflows, billions of USD

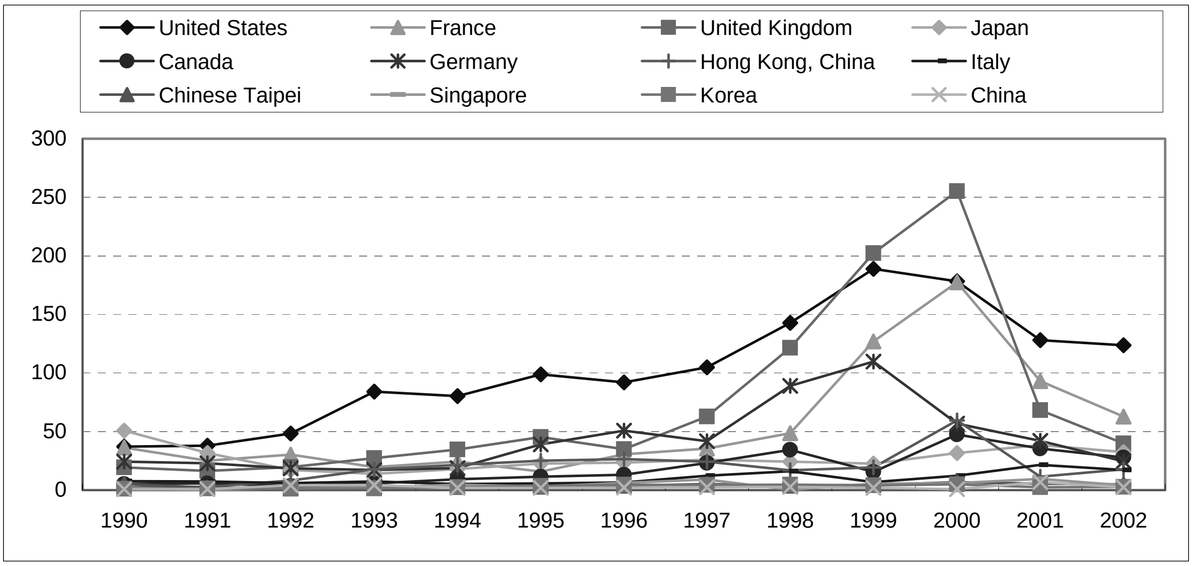


Note: Data for 2001 are provisional and for 2002 estimated.

Source: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

The outflow of FDI saw of course the same drop after the year 2000, which can be seen in Figure 29. China is not yet an important source of FDI outflows, showing very little development over the last 12 years.

Figure 29. FDI outflows, billions of USD

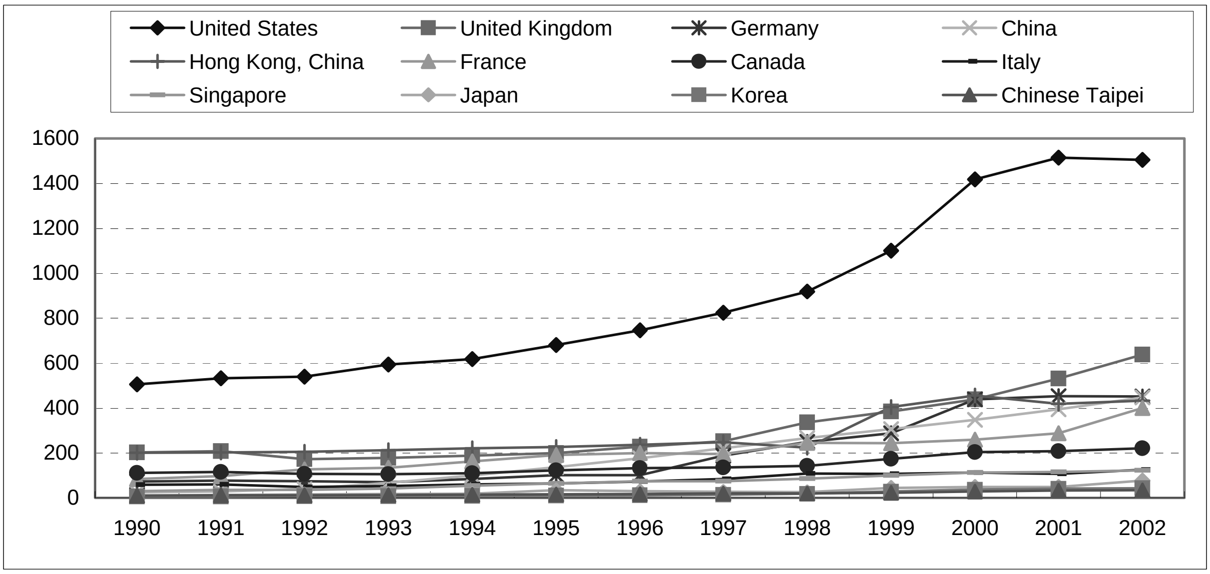


Note: Data for 2001 are provisional and for 2002 estimated.

Source: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

As a result of the sustained high levels of FDI inflows, the level of FDI stocks in China has risen substantially as well (see Figure 30). In 2002, China's inward position of direct investment from abroad stood at USD 448 billion, which for the first time was more than the inward stock of FDI in Hong Kong, China.

Figure 30. FDI inward stocks, billions of USD

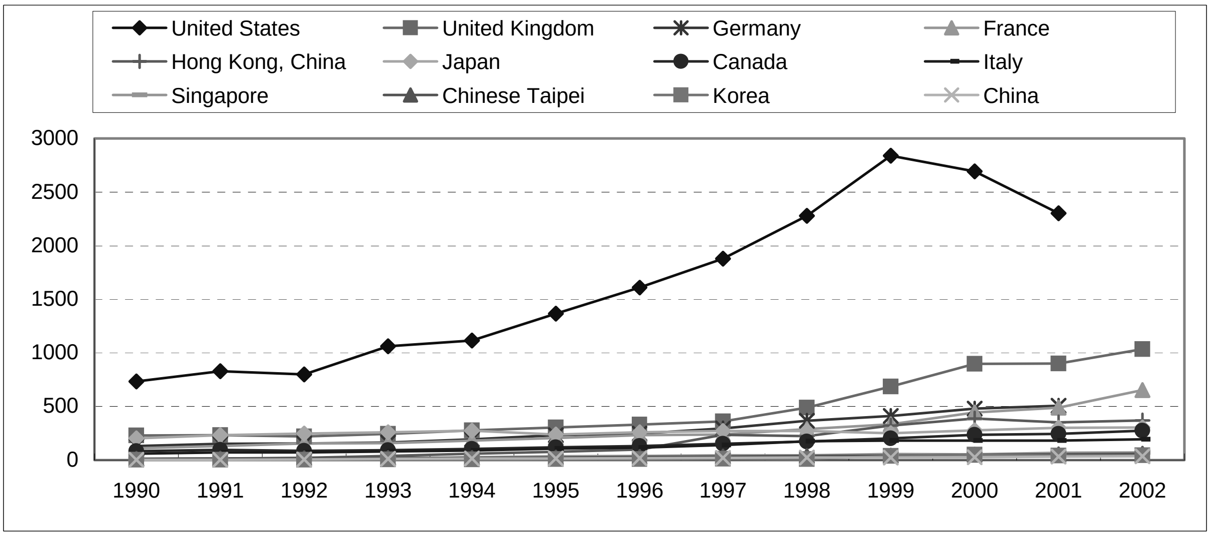


Note: data for 2001 are provisional and for 2002 estimated.

Source: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

In contrast, China's outward position is still of minor importance. At USD 36 billion in 2002, it occupied the last position in the list of economies shown here (Figure 31).

Figure 31. FDI outward stocks, billions of USD



Note: Data for 2001 are provisional and for 2002 estimated.

Source: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

HUMAN RESOURCES

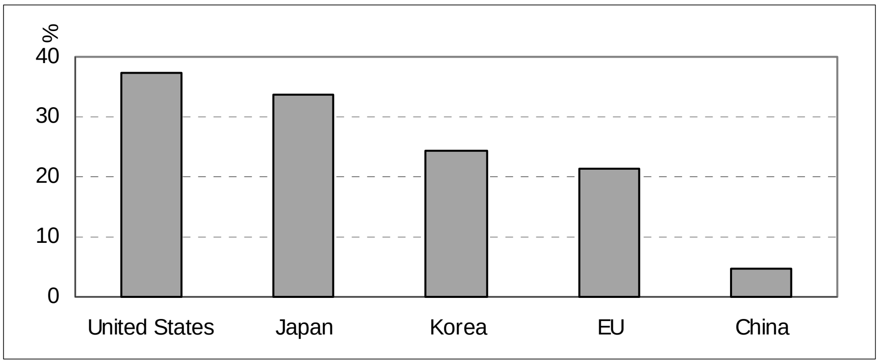
In the economic development of a country, or for an economy to increase its knowledge base, human resources are crucial. Without a sufficient number of people with a proper set of skills and training, any attempt to progress as an economy is bound to fail. Human capital is heterogeneous: no single variable or indicator can adequately represent the many human characteristics that bear on the economy and society. While the level of individuals' skills, knowledge and competencies can be taken to represent the "stock" of human capital at any one time, these various attributes cannot be easily quantified.

Educational attainment

Educational attainment relates to the stock of knowledge and skills in the population, and is the most commonly used proxy for human capital. The data here present the share of the population aged 25-64 that has attained tertiary education, and refer to the population as a whole. The International Standard Classification of Education (ISCED-1997) classifies educational attainment in six categories of educational programmes, two of which (categories 5A and 6) are for university degree or equivalent. ISCED 5A programmes are largely theoretically based and are intended to provide sufficient qualifications for gaining entry into advanced research programmes and professions with high skills requirements. ISCED 5B programmes are generally more practical/technical/occupationally specific. ISCED 6 programmes lead to an advanced research qualification and are devoted to advanced study and original research (*e.g.* PhDs). Tertiary level is defined as ISCED-1997 levels 5B, 5A and 6.

In the United States, 37% of the population aged 25-64 has completed tertiary-level education in 2001, while in Japan this share stood at 34% (see Figure 32). These shares were considerably higher than the corresponding shares for Korea (24%) and the EU (21%). Compared with these shares, the share of the Chinese population with tertiary education was very low, at 5% only. This however, still represents 31 million people aged 25-64 years. Therefore, the fact that China nevertheless is developing rapidly is due to the large population base where skilled people can be drawn from.

Figure 32. Share of the population aged 25-64 that has attained tertiary education, 2001



Source: OECD, Educational Attainment and Education Databases.

Enrolments in tertiary level education

The higher education system is the main source of human resources in science and technology for the labour market. It is complemented by immigration of highly skilled workers from abroad and internal mobility flows. The input and output of higher education, that is enrolments and graduates, are therefore important indicators.

In 1999, long term aims were set by China for the development of all types of education towards the year 2010. The goal for tertiary education was to achieve an enrolment ratio of 15% of the 18-22 age group. There are fairly clear indications that that target will be achieved ahead of time. In 1999, the gross enrolment ratio[3] for tertiary education was 10.5%, and it was 11% in 2000[4]. In 2002 it reportedly already reached 14.7%.

In 2001, around 1.3 million students in the United States and the EU and around 1.2 million students in China were enrolled in higher education (see Figure 33). Almost 40% of the Chinese students were new entrants, a substantially higher proportion than that of the EU (20%) and the United States (16%). In absolute numbers Chinese enrolments match those of the United States and the EU, and the number of new entrants in China is as high as the combined total for the Unites States and the EU. However, because of the much larger population size of China, the entry rate for China is much smaller than the entry rates for the other economies[5].

Official data put the net entry rate of new entrants in ISCED 5B programmes for the United States at 13% and the net entry rate in ISCED 5A programmes at 42%[6]. For Japan, gross entry rates in B-type programmes reached 31%, while the rate for A-type programmes stood at 41%. For Korea, the equivalent numbers were even higher, at 55% and 49% respectively. For China gross entry rates have been approximated using UN population data by 5-year age-groups, assuming an even spread over the single ages. The resulting estimate puts the Chinese gross entry rate for new entrants in ISCED 5A programmes at around 12%, and for new entrants in ISCED 5B programmes at around 12% as well. This is a marked increase with the previous year, when these rates stood at 7% and 5% respectively, but it is still significantly lower than for the other countries.

---

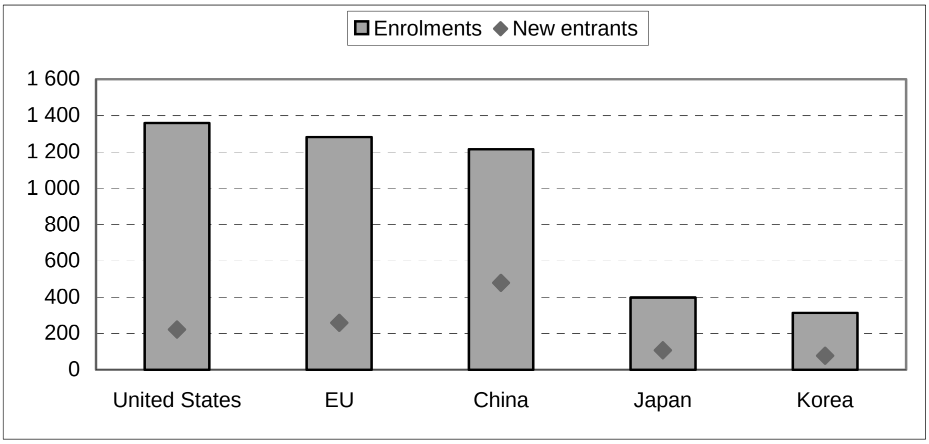
3. The gross enrolment ratio is calculated by dividing the number of students enrolled in a given level of education regardless of age by the population of the age-group which officially corresponds to the given level of education, and multiplying the result by 100.

4. See OECD (2001).

5. Entry rates represent the proportion of persons of a certain age who enter a certain level of tertiary education at one point during their lives. A difference can be made between net and gross entry rates. The total net entry rate is the sum of the proportions of new entrants to ISCED 5A and 5B programmes aged *i* to the total population aged *i*, summed up over all ages. In the case where no data on new entrants by specific age are available, gross entry rates can be calculated. Gross entry rates are the ratio of all entrants, regardless of their age, to the size of the population at the typical age of entry.

6. Entry rates for type A and B programmes cannot be added because some students enter both types of programmes.

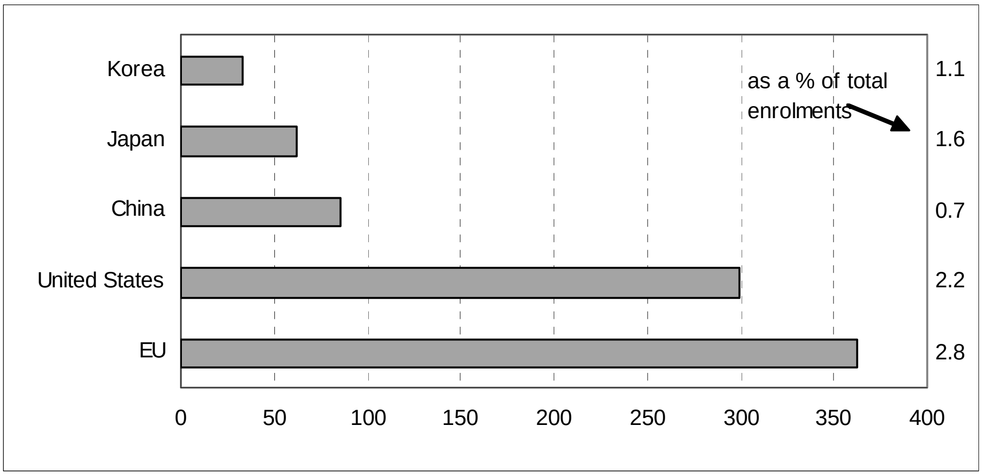
Figure 33. Number of students enrolled in tertiary education, 2001 (thousands)



Source: OECD Education database.

People with advanced degrees have the skills to carry out original research and are essential for the functioning of a knowledge-based economy. While the absolute enrolment in tertiary education is now as high in China as in the United States or the EU, enrolments in advanced research programmes (ISCED 6, as described before) are still lagging. In 2001, approximately 86 000 Chinese enrolled in such programmes, which was equal to 0.7% of total enrolments. In the EU and the United States these ratios were much higher at 2.8% and 2.2% respectively (see Figure 34).

Figure 34. Enrolments in advanced research programmes, 2001 (thousands)



Note: Advanced research programmes data for the EU exclude data for Germany.

Source: OECD education database.

Graduates of tertiary education

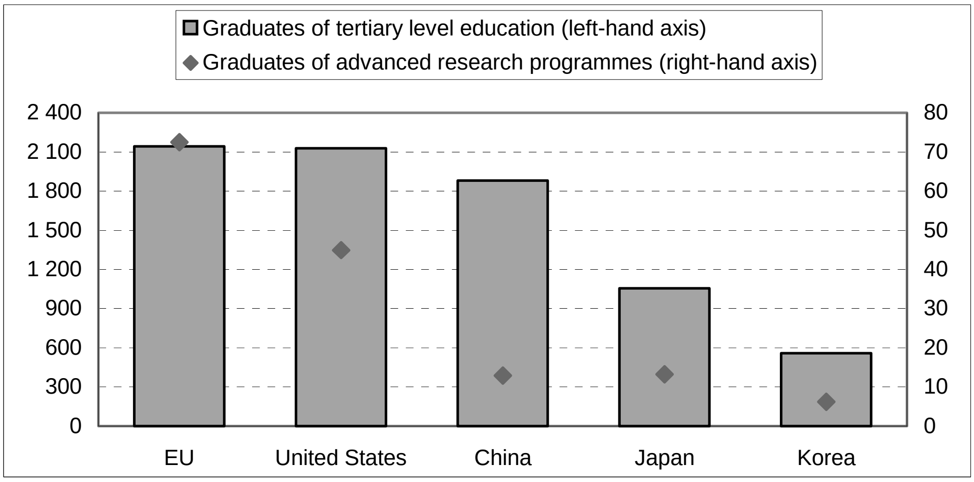
Flows of university graduates are an indicator of a country's potential for diffusing advanced knowledge and supplying the labour market with highly skilled workers.

The bars of Figure 35, using the left-hand axis, sum all graduates of tertiary education. In absolute numbers, the EU and the United States awarded an equal number of tertiary level degrees, 2.1 million in

2001, closely followed by China with 1.7 million degrees. Once again, taking population size into account leads to a different perspective on the Chinese figure. An unofficial estimate[7] indicates that the proportion of the population at the typical age for graduation completing a tertiary level degree in China was in 2001 about five time smaller than the same proportion in the United States or the EU. For Japan and Korea these ratios were even higher than the US and EU ratios.

The diamonds of Figure 35, using the right-hand axis, show the number of graduates of advanced research programmes, such as PhDs. In 2001, the EU awarded most of these advanced degrees, around 72 500, followed by the United States (around 45 000), at a distance followed by Japan (approximately 13 200) and China (in the region of 12 900).

Figure 35. Graduates of tertiary level education, 2001 (thousands)



Notes: Data for China refer to public institutions only; data for graduates of tertiary level education for the EU exclude Greece and data for graduates of research programmes exclude Greece and Portugal.

Source: OECD education database.

Graduation rates for advanced research programmes represent the number of people receiving an advanced research degree (level 6 of ISCED-1997) as a percentage of the population at the typical age of graduation. Net graduation rates are calculated by summing graduation rates across individual years of age. However, if the net graduation rate cannot be calculated, gross graduation rates are used, which are calculated as the percentage of graduates in the population at the typical age of graduation. For the United States, the official net graduation rate stood at 1.32% in 2001. The rate for the EU can roughly be estimated to be of the same order of magnitude. The official Korean rate was 0.76%, followed by Japan at 0.65%. For China, this number has been estimated using UN population data for 25-29 year olds, dividing the result by 5, assuming an even spread over the single ages. The result was a graduation rate of only around 0.05%, far below that of the other economies.

One of the conclusions that can be drawn from this section is that although in relative terms the Chinese output from the higher education system is not impressive, because of the enormous size of the population this still represents a number comparable to those of the big economies of the United States and the EU.

7. These estimates were made by dividing graduation data by UN population data for 20-24 year olds, dividing the result by 5, assuming an even spread over the single ages.

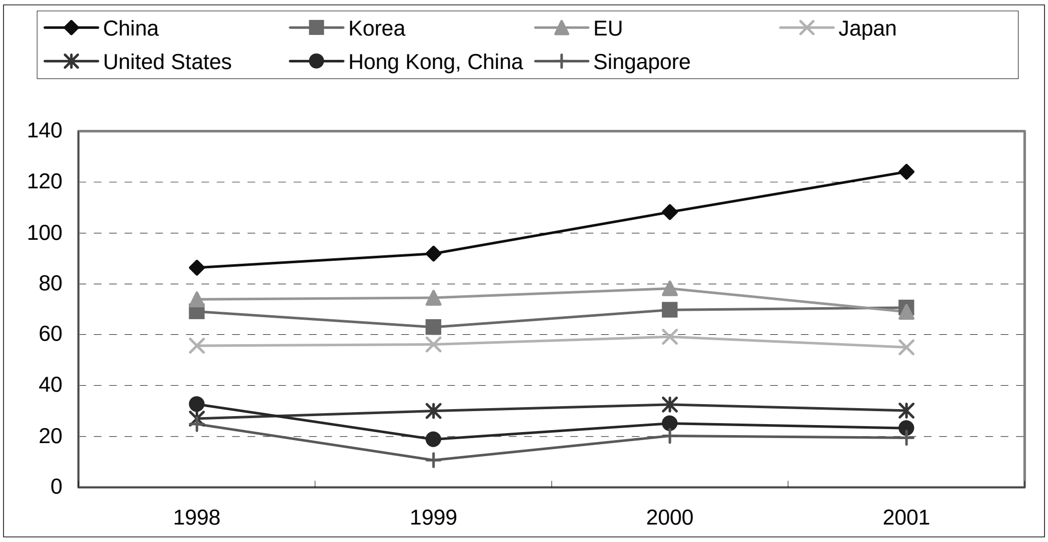
International mobility

International mobility of students is an indicator of the internationalisation of both the higher education sector and the research system. Students who enrol in a foreign country may decide to stay and look for work or engage in further study in the host country. This way, they may contribute to the advancement of research in the host country, although they may later take their experience home.

Foreign students

A considerable number of Chinese students enrol in higher education studies in OECD countries, a number which has been steadily rising, from around 86 000 in 1998 to approximately 124 000 in 2001 (see Figure 36). Considering the much smaller population sizes of Hong Kong, China and Singapore, the number of students from these economies studying abroad in OECD countries is significant as well.

Figure 36. Number of foreign students enrolled in tertiary education in OECD countries, by country of nationality (thousands)



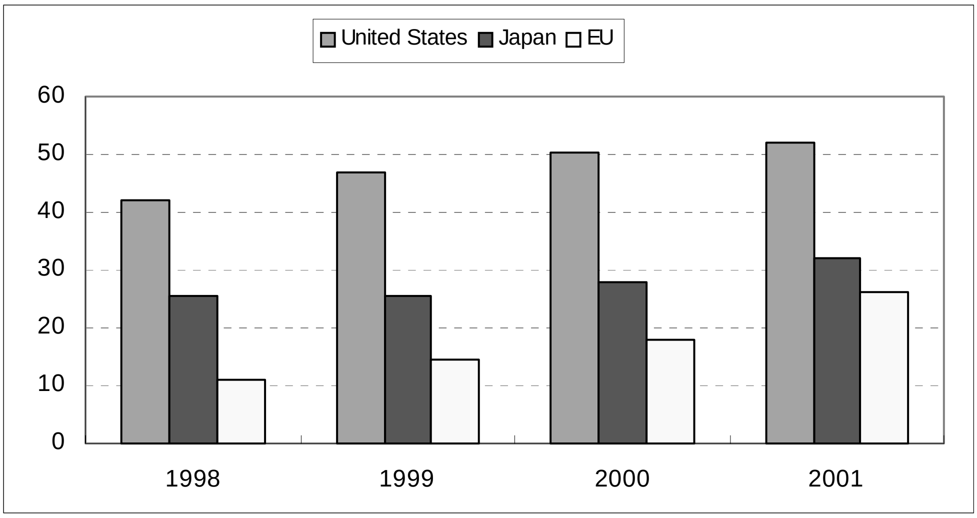
Note: Data for the EU exclude intra-EU flows.

Source: OECD, education database.

Figure 37 shows that in 2001, in the region of 52 000 of the Chinese students enrolled in OECD countries were studying in the United States, equivalent to 42% of the total number of Chinese students enrolled in OECD countries. This was a decrease in share compared with the preceding years, but a steady increase in the absolute number of students. In 2001, 26% of the Chinese students studying in OECD countries were enrolled in Japan and 21% in the EU.

In total, there were approximately 126 000 Chinese students enrolled in OECD countries in 2001, equal to 8% of the total number of foreign students. In Korea, half of the foreign students were Chinese, in Japan this percentage stood at 43%, in the United States it was 11%, while in the EU it stood at 3% only.

Figure 37. Number of Chinese students enrolled in tertiary education in the United States, Japan and the EU, (thousands)



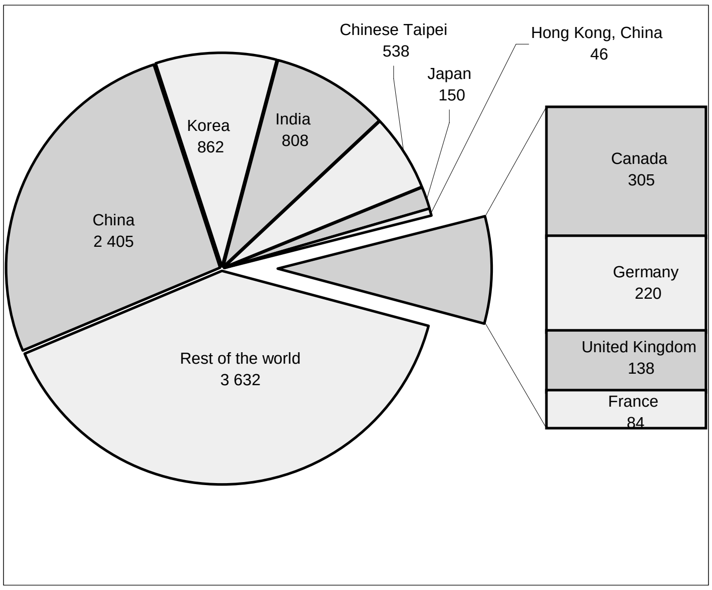
Source: OECD, education database.

Highly skilled migration to the United States

In recent years, the international mobility of highly skilled workers has received increasing attention from policy makers and the media. However, internationally comparable data on international flows of scientists and researchers are extremely scarce. Two indicators are presented here that give an indication of the attractiveness of the United States for foreign students and scholars.

Every year between 1992 and 2001, almost 10 000 non-US citizens were awarded a doctoral degree in the sciences or in engineering in the United States. In 2001, this number stood at 9 188, of which just more than a quarter were Chinese citizens (see Figure 38). The second largest group of foreigners were Koreans (9.4%), followed by Indians (8.8%) and students from Chinese Taipei (5.9%). Asian students therefore represent the bulk of PhDs awarded to foreigners in the United States, although their numbers have diminished over the decade in the case of India, Korea, Chinese Taipei and Hong Kong, China. The Chinese number has fluctuated between 2 000 and 3 000, with an average of 2 400 over the decade.

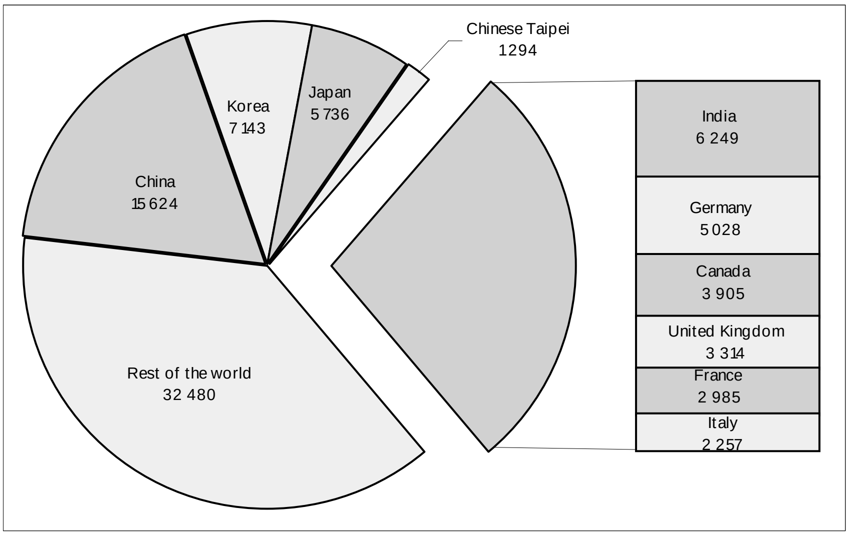
Figure 38. Number of science and engineering doctorates awarded to foreign citizens in the United States, by country of citizenship, 2001



Source: National Science Foundation/Division of Science Resources Statistics, Survey of Earned Doctorates.

It is estimated that foreign scholars (non-immigrant, non students academics – *i.e.* university teachers and researchers) represent 30% to 40% of total university researchers in the United States. In 2001-2002, universities in the United States received 86 015 foreign scholars (non-immigrant, non-student academics) against 59 981 in 1993-1994 (see Figure 39). This represents an average annual growth of 4.6%. More than 18% of these foreign scholars came from China which was the main source, far ahead of other countries.

Figure 39. Number of foreign scholars in the United States, by country of origin, 2001-02



Source: OECD, based on data from the Institute of International Education (IIE), October 2003.

Human resources in R&D

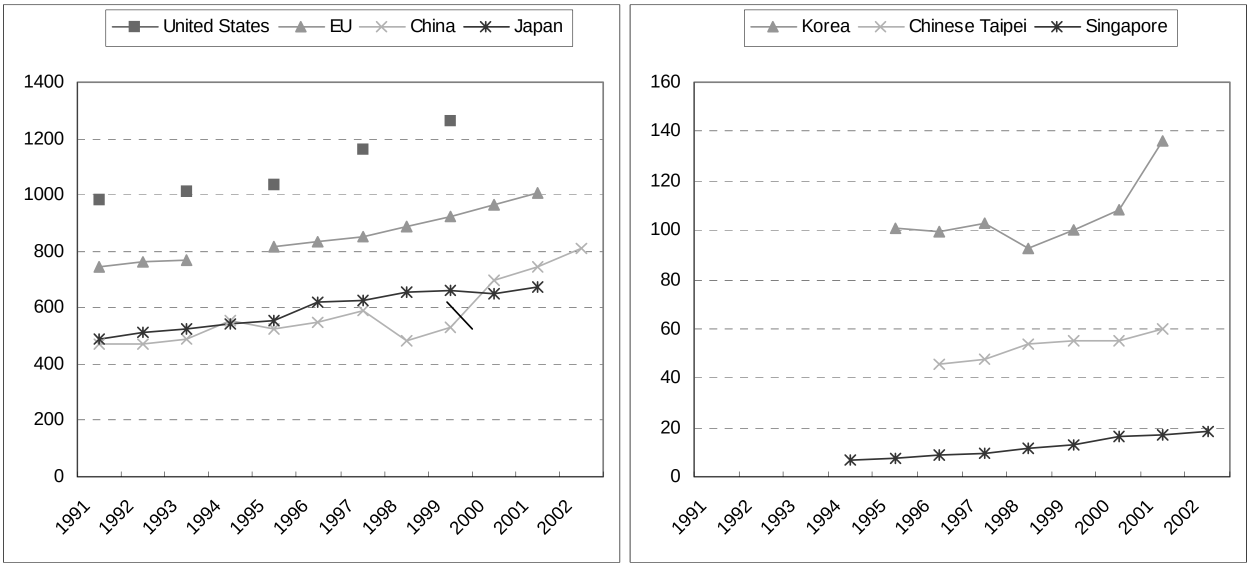
An important occupational category in a knowledge-based economy is that of highly skilled workers active in research and development. It is difficult to compare China's R&D expenditures with those from other countries for a variety of reasons, described in the next section. Nevertheless, counting the people that are involved in research activities avoids some of the pitfalls that were outlined before in the section on economic structure, such as finding suitable deflators or conversion rates.

Researchers

Researchers are viewed as the central element of the research and development system. They are defined as professionals engaged in the conception and creation of new knowledge, products, processes, methods and systems and are directly involved in the management of projects. The number of researchers is expressed in full-time equivalent (FTE, *i.e.* a person working half-time on R&D is counted as 0.5 person-year) and includes staff engaged in R&D during the course of one year. FTE data on researchers give an indication of countries' research effort and are different from headcount data, which are a measure of the stock of researchers employed. The data have been compiled on the basis of the methodology of the *Frascati Manual* (OECD, 2002b).

In most economies, the number of researchers has been growing steadily over the last decade, which can be seen in Figure 40. The data for China show slow growth between 1991 and 1997, followed by a drop in 1998 and a slight recovery in 1999. Since 1999 however, the figure has soared from around 531 000 in 1999 to around 811 000 in 2002. Part of this growth can be ascribed to improved measurement (see Box 5), while another part of the growth could be related to China's intention to increase the national R&D effort significantly during the 10th Five-Year Plan (2001-05). China now counts more researchers than Japan (approximately 676 000 in 2001) and is quickly approaching the level of the EU (1 million in 2001).

Figure 40. Number of researchers, thousands of FTE



Note: * There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1993 and for the EU in 1997.

Source: OECD, MSTI database.

Box 5. Methodological notes on the R&D expenditure and personnel data

For **China**, before 2000, all of the personnel data and 95% of the expenditure data in the business enterprise sector covered only large and medium-sized enterprises. Since 2000 however, the survey has been extended to cover almost all industries and all enterprises above a certain threshold. Furthermore, due to the reform of the S&T system some government institutions have become enterprises, and their R&D data have been added to the enterprise sector since 2000.

Furthermore, before 2000, the breakdown by sectors of performance was incomplete; the sum of the elements did not add up to the total.

The R&D expenditure data for the **United States** are somewhat underestimated for a number of reasons: R&D performed in the Government sector covers only federal government activities. State and local government establishments are excluded; in the Higher Education sector R&D in the humanities is excluded, as are capital expenditures; R&D expenditure in the PNP sector covers only current expenditure. Furthermore, depreciation is reported in place of gross capital expenditures in the Business Enterprise sector.

Underestimation of researchers in the United States is due to the exclusion of military personnel in the government sector.

Up to and including 1995, **Japanese** data for R&D personnel was expressed as the number of physical persons (working on R&D) rather than in terms of full-time equivalent. In consequence R&D personnel and labour cost data were overestimated by international standards. Studies by some Japanese authorities had suggested that in order to reach FTE the numbers of researchers might be cut by perhaps 40% in the Higher Education sector and by about 30% for the national total. In consequence HERD would be reduced by about 25% and GERD by about 15%. In consequence, OECD calculated “adjusted” Japanese series (expenditures and researchers) for the Higher Education sector and for the national totals up to 1995 for use in its own reports. Until 1996, therefore, data for Japan are Secretariat estimates, based on national data, but data are still likely to be overestimated. From 1996, data for R&D personnel are expressed in full-time equivalent. Therefore, labour cost data are no longer overestimated.

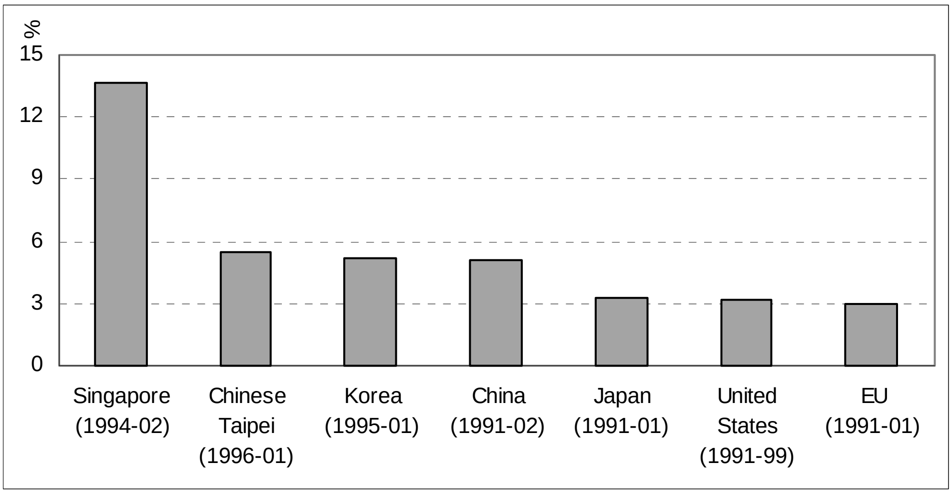
In **Korea**, social sciences and humanities are excluded from the R&D data.

In **Chinese Taipei**, postgraduate students engaged in R&D are not included in the higher education sector; researchers must have a university degree or above. Furthermore, defence R&D is excluded from the data.

Data for the **European Union** are Secretariat estimates, provisional for the year 2001. For 1991 and 1992 there are breaks in series with the previous year.

Figure 41 shows the annual average growth rates over the last 10 years or so, the exact years differ by country, depending on the availability of data. Singapore has shown the strongest growth, at a steady 13.6% per year, followed by two other dynamic Asian economies, Korea and Chinese Taipei. In view of the surge since 1999, the growth rate for China is relatively modest, because of the drop in 1997-1998. Nevertheless, its average growth rate was still 2 percentage points higher than the growth rates of Japan, the United States and the EU.

Figure 41. Researchers, annual average growth rate (various years)

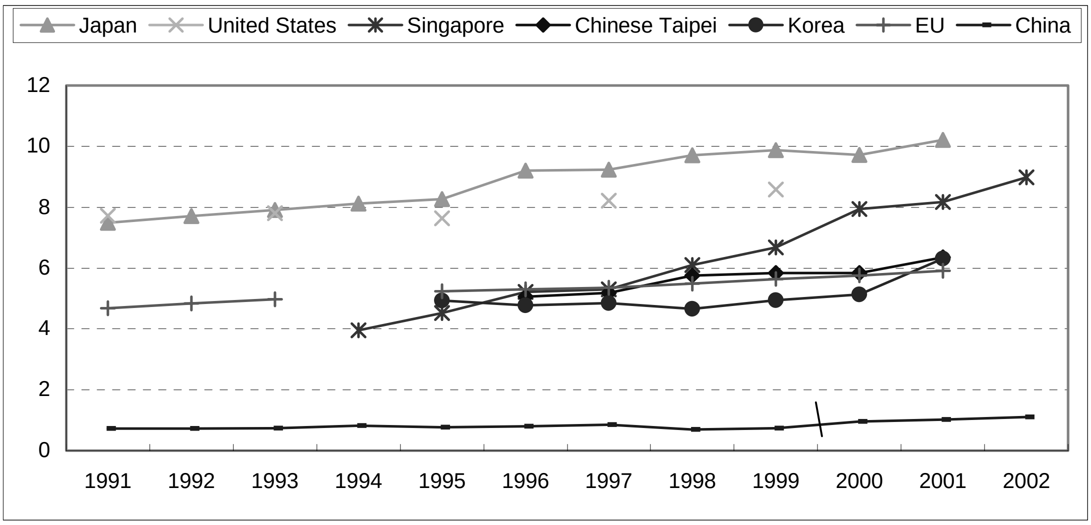


Notes: There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1993 and for the EU in 1997.

Source: OECD, MSTI database.

As seen before, China profits heavily from its large population base, which allows it to match the number of skilled resources in smaller, but more developed economies such as the EU, the United States and Japan. Figure 42 spells this out, by normalising the researcher data, using employment as the denominator. When expressed per thousand employed, Japan employed the highest number of researchers, with Singapore rapidly approaching. In comparison, the number for China is between six and ten times smaller.

Figure 42. Researchers per thousand persons employed



Notes: *There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1993 and for the EU in 1997.

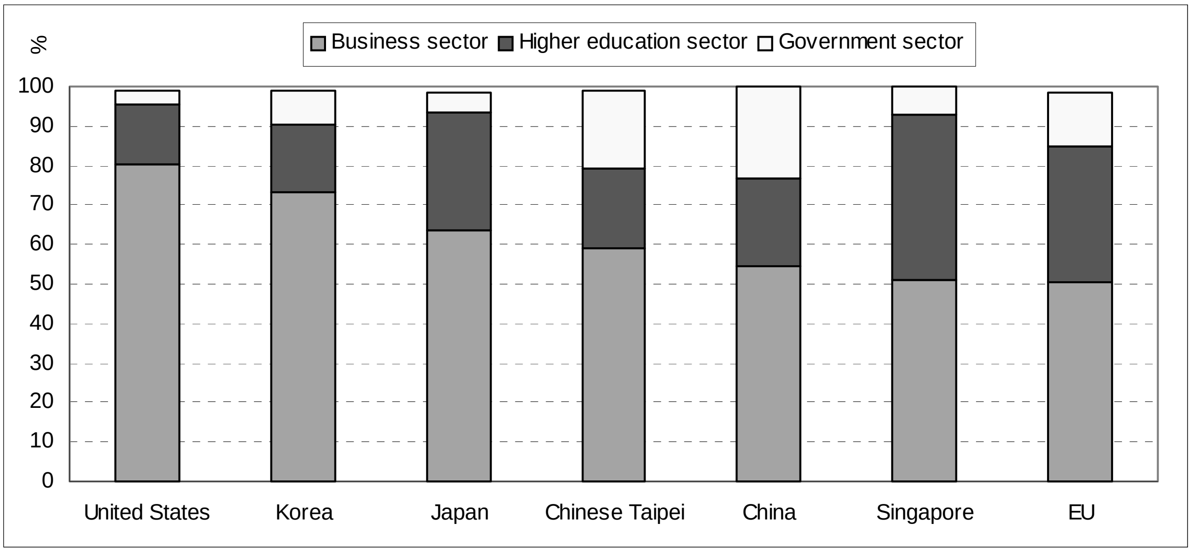
Source: OECD, MSTI database.

Researchers by sector of performance

Research can be carried out by different institutional sectors. The business enterprise sector covers researchers carrying out R&D in firms and business enterprise sector institutes, while the government and the higher education sectors also carry out R&D. Industrial R&D is the most closely linked to the creation of new products and production techniques.

The United States has the largest share of researchers in the business sector (81%), followed by Korea (73%) and Japan (64%) (see Figure 43). China's share, at 55%, can be considered very high for a developing country, exceeding that of the EU.

Figure 43. Breakdown of researchers by sector of performance, 2001 (%)



Notes: China and Singapore 2002; United States and the EU 1999; see Box 5 for methodological notes.

Source: OECD, MSTI database.

R&D EXPENDITURE

Resources allocated to a country's R&D efforts are measured using two indicators, R&D personnel as shown in the previous section, and R&D expenditure. For R&D expenditure, the main aggregate used for international comparisons is gross domestic expenditure on R&D (GERD), which represents a country's domestic R&D-related expenditure for a given year. The R&D data are compiled on the basis of the methodology of the *Frascati Manual*. Since data on R&D expenditure are by definition financial data, the same problems are encountered as for other monetary indicators, namely how to compare the Chinese data with those of other economies. Box 1 in the section on economic structure summarises the most problematic issues, which reappear in this section.

Before evaluating the R&D expenditure data, some insights from Chapter 6 of *"China in the World Economy"* (OECD, 2002a) are reproduced below, in order to better understand the way R&D is organised and performed in China.

- Under a planned economy, state-owned enterprises (SOEs) are connected to state development plans, and are therefore in a favourable position to receive state allocations of various funds for innovation and technological upgrading. Moreover, they enjoy better access to the capital market for financing. China's R&D resources have therefore been channelled to SOEs, which lack the incentive to undertake R&D, while the smaller and non-state enterprises, which are more motivated to innovate, cannot get the resources they need.

- The legacy of the planning system is also reflected in the allocation of human resources in Chinese enterprises. Since fulfilling production targets was the most important objective for enterprises under the planning system, enterprise managers assigned the most qualified personnel to the production lines, leaving less qualified personnel to work on technological innovation, which is a relatively low priority.

- Market institutions are still underdeveloped and effectively inadequate to regulate market behaviour in China. Consequently, technological advantage does not necessarily determine which of the enterprises will win competition, as other factors tend to play a more important role. This market environment has discouraged Chinese enterprises from undertaking R&D and other efforts to improve their product qualities and technical standing.

- The lack of an exit mechanism of non-viable firms results in serious over-capacity in Chinese industries, which further intensifies price competition in the product markets. As a result, excessive price competition drives down profit levels of even viable firms, consequently weakening the financial ability of these firms to invest in R&D and innovation.

- In many SOEs, managers are still appointed by their superior administrative agencies and careers are not determined, or significantly influenced, by the performance of the enterprises that they manage. Since many of these managers' posts are of a political nature, and they are likely to be reassigned to a new post in a few years time, managers tend to be more interested in working on short-term issues with low risks. However, since investment in R&D often carries high risk and may take a long time to deliver economic returns, R&D tends to be treated as a low priority by SOE managers. Because of this low priority, management of technological innovation is, consequently, weak in Chinese enterprises.

- Chinese enterprises are adversely affected by the poor protection of intellectual property rights (IPR) in two ways. First, as many enterprises rely on copying and imitating others' production technology and product designs, they find little need to invest in their own R&D and innovation. Secondly, in enterprises that do put resources into R&D, their investment interest is hampered by the fact that their R&D results cannot be effectively protected in the market.

- The quality of the Chinese R&D personnel is generally low and unsatisfactory. The problem appears to start from the Chinese education system, which emphasises theoretical and exam-oriented learning at the expense of practical and problem-solving skills. This is further worsened by the lack of investment in personnel training in the enterprise sector, which limits the knowledge upgrading of technical personnel. Furthermore, China has experienced a major brain drain in the last two decades, with a large number of educated Chinese going abroad to study, and the majority have not yet returned to China.

- Financial instruments for R&D and innovation are poorly developed in China. The planning system and the corporate finance system are not designed to meet the needs of R&D funding and innovation. Venture capital, as a source of R&D funding, is not widely available to many Chinese enterprises, as it is still new and underdeveloped, and often run by the government in China. In any case, there is a lack of incentive for Chinese enterprises to devote their resources to R&D, since returns on investment in other activities tend to be higher and more immediate.

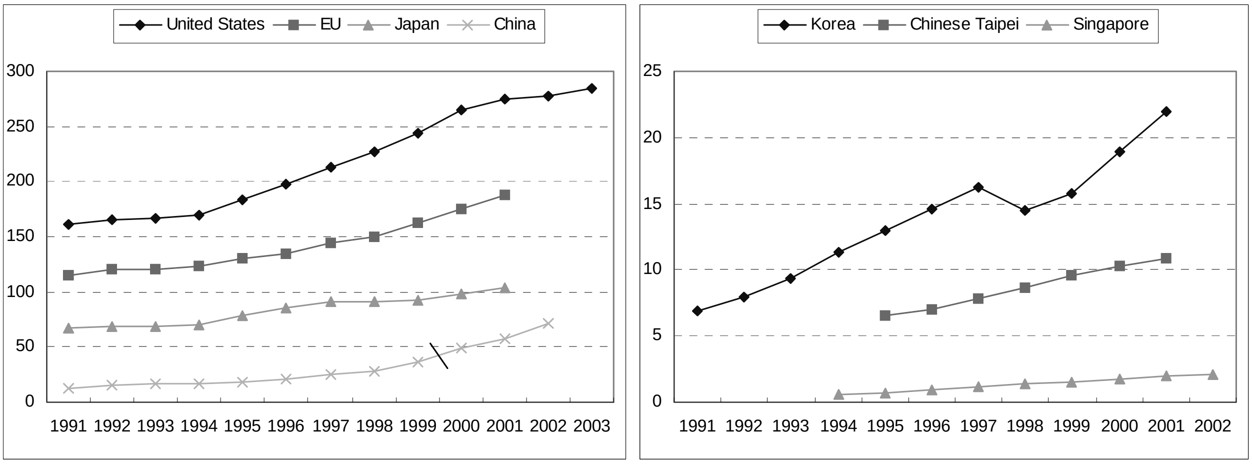
- Technology diffusion is fundamentally important for technological upgrading, but Chinese industries devoted very limited efforts and resources to technological diffusion in the past, preferring the (more expensive) import of technology. The absence of technology transfer channels to diffuse research results from public-funded research institutes to industry is another major bottleneck of the Chinese innovation system. Furthermore, as industries, universities, and R&D institutions belong to different administrative systems in China, it prevents the free flow of resources and knowledge between them.

- China has adopted certain policies that restrict foreign direct investment from entering into certain industries, and that encourage foreign direct investment in priority industries, imposing limits on the share of foreign ownership in joint ventures and the choice of investment forms in some other cases. These types of policies have had restrictive effects on the transfer of foreign technology to China.

- Restrictions imposed on the share and forms of foreign ownership have a direct impact on foreign investors' interest in transferring technologies to their operations in China. Unless foreign investors can have majority control of enterprises, their interest in transferring core technology is limited.

Figure 44 shows the evolution of GERD, with the data expressed in current PPPs. For the conversion of Chinese data from national currency into PPP, the World Bank PPP rate has been used, as is customary in OECD's *Main Science and Technology Indicators* (MSTI) publication. As explained in Box 1, it is possible that this leads to overestimated figures for China, which can be significant. Using PPPs, China has been catching up rapidly, especially since 1999, and – at 72 billion PPP dollar in 2001 – is currently positioned behind the United States (285 billion PPP dollar in 2003), the EU (187 billion in 2001) and Japan (104 billion in 2001), but ahead of all other economies, including individual Member States of the EU. Part of the growth between 1999 and 2000 is not solely due to economic factors, but can be ascribed to improved measurement methods (see Box 5).

Figure 44. Gross Domestic Expenditure on R&D, billion current PPPs



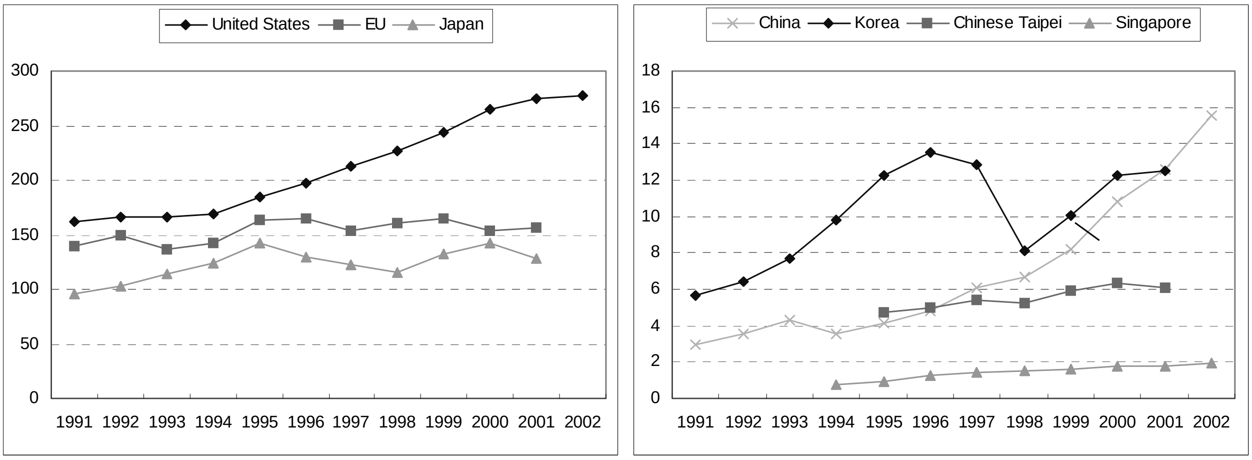
Notes: *There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional.

Source: OECD, MSTI database.

To put the results for China into perspective, Figure 45 shows again the evolution of GERD, but this time expressed in current USD, converted from national currencies using exchange rates. Using this conversion factor shifts China's position down to a level comparable to that of Korea. Using exchange rates, China spent USD 16 billion on R&D in 2001, which put it not only behind the United States, the EU and Japan, but also significantly behind the EU Member States Germany, France and the United Kingdom. Although exchange rates are not the most suitable way of comparing different economies, as has been explained in Box 1, in the case of China the difference between using PPPs and using exchange rates is larger than usual for developing countries. As was stated for GDP, it is likely that using PPPs gives an upper bound of the "true" level of R&D expenditure, while using exchange rates gives a lower bound. Where exactly the best estimate can be found remains a matter for discussion and further analysis. Most of Chinese research is likely to be done in urban areas rather than in rural areas. Since the price level in Chinese cities is higher than in rural China, a case can be made for using a conversion factor that is closer to the upper bound than to the lower bound[8].

8. While it is true that in other economies as well there will be a difference in price level between urban and rural areas, it is likely that this difference is more significant for China, especially when compared with more developed economies.

Figure 45. Gross Domestic Expenditure on R&D, billion current USD (based on exchange rates)

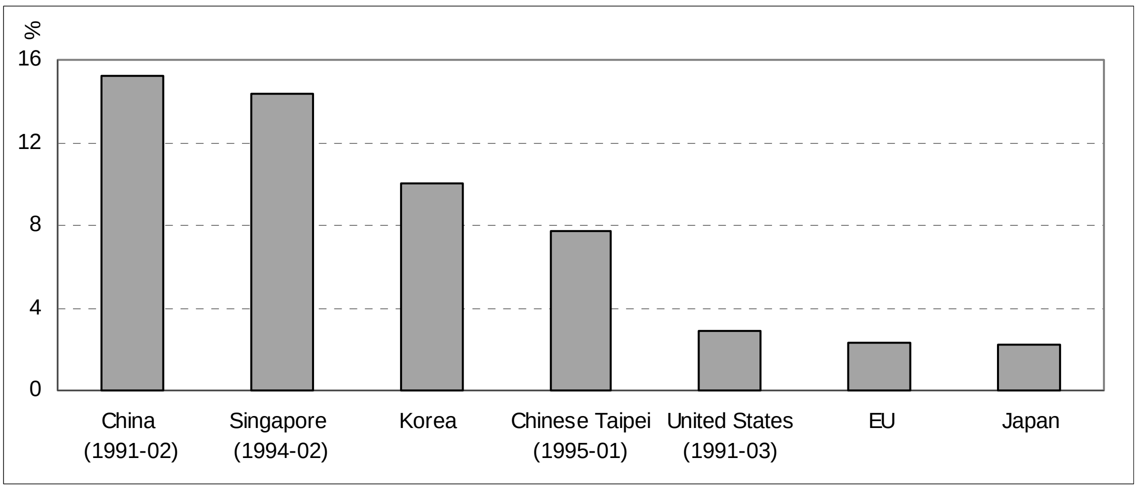


Notes: * There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional.

Source: OECD, MSTI database.

Independent of which measure is used, the growth of China's R&D expenditure has been impressive. Between 1991 and 2002, the R&D effort increased on average by 15.2% annually in real terms (see Figure 46). Since there is a break in series between 1999 and 2000, in reality this figure is probably a bit lower. However, in recent years the growth has been even more remarkable. Between 2000 and 2002, Chinese GERD grew by 20.6% in real terms annually. The other fast developing Asian economies also show elevated annual average growth rates between 10% and 15% during the last decade. In contrast, growth in the big economies was between 2.2% and 2.9% per annum.

Figure 46. Growth of R&D expenditure, annual average growth rate 1991-2001 (based on national currencies in constant prices)



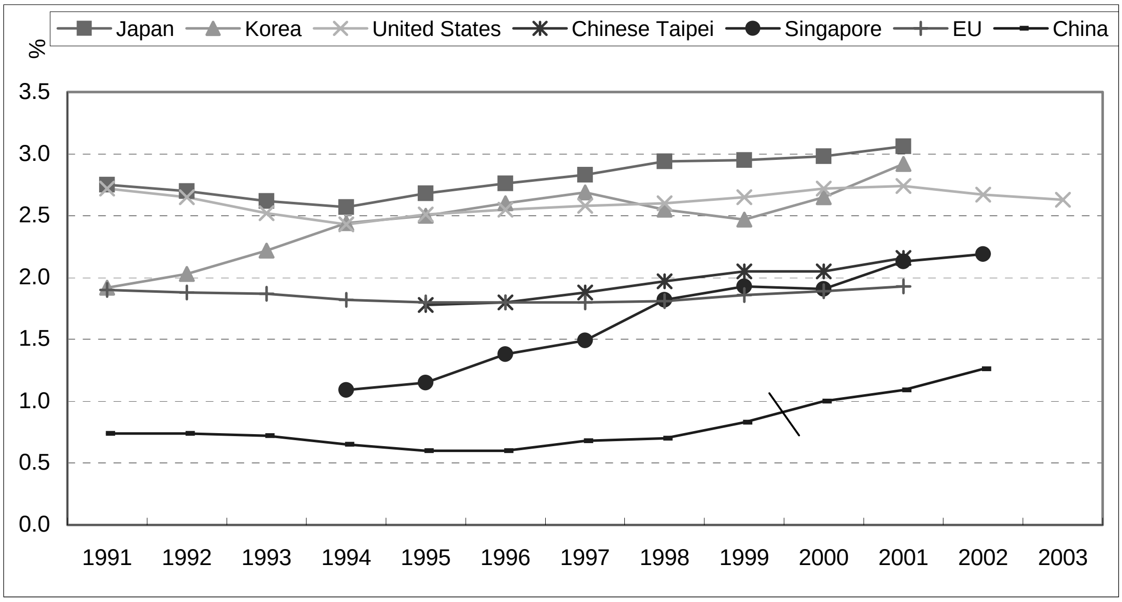
Notes: There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional.

Source: OECD, MSTI database.

A common way of circumventing the search for suitable conversion rates is by looking at R&D intensities, which is defined as the proportion of GDP devoted to R&D. For this indicator to be meaningful requires that the relative price of GDP and R&D are similar. If the price structure for R&D and GDP are not similar, even intensity comparisons can be biased. For example, if R&D wages in an economy diverge significantly from the GDP price level, this can bias the R&D intensity significantly. In the case of China, given the inherent sophistication of R&D labour relative to the more low-technology national average, it is possible that the R&D intensity for China is biased upwards.

After being stable between 1991 and 1998, since the end of the 1990s, the Chinese R&D intensity has rapidly increased, from 0.7% of GDP to 1.3% in 2002 (see Figure 47). In China's 10th Five-Year Plan (2001-05), the government expressed its intention to boost R&D funding, with as objective that the national R&D effort reach 1.5% of GDP by 2005. If the collected statistics correctly reflect the present situation, they seem poised to reach this ambitious target. Still, China's current proportion is only half of the proportion in the United States, which registered the same R&D intensity in 2002 as it did in 1991. China is quickly approaching the EU, which has been stable at 1.9%. Extrapolating the current trends, China could reach the EU level before 2010. Whether this will really happen depends on many things. One question is whether China's current expansion is sustainable. Will the research system be able to absorb the extra efforts, both in the form of financial incentives and in the form of extra manpower? Another counter argument is that the EU is committed to increase its research efforts to 3% of GDP by the end of the decade, in order to comply with the target set at the Barcelona summit. Despite closing in on Japan in absolute terms, in relative terms China is still far away, Japan having an intensity of 3.1% in 2001, up from 2.8% in 1991. The three other dynamic Asian economies also registered substantial increases in their R&D intensity.

Figure 47. R&D expenditure as a percentage of GDP

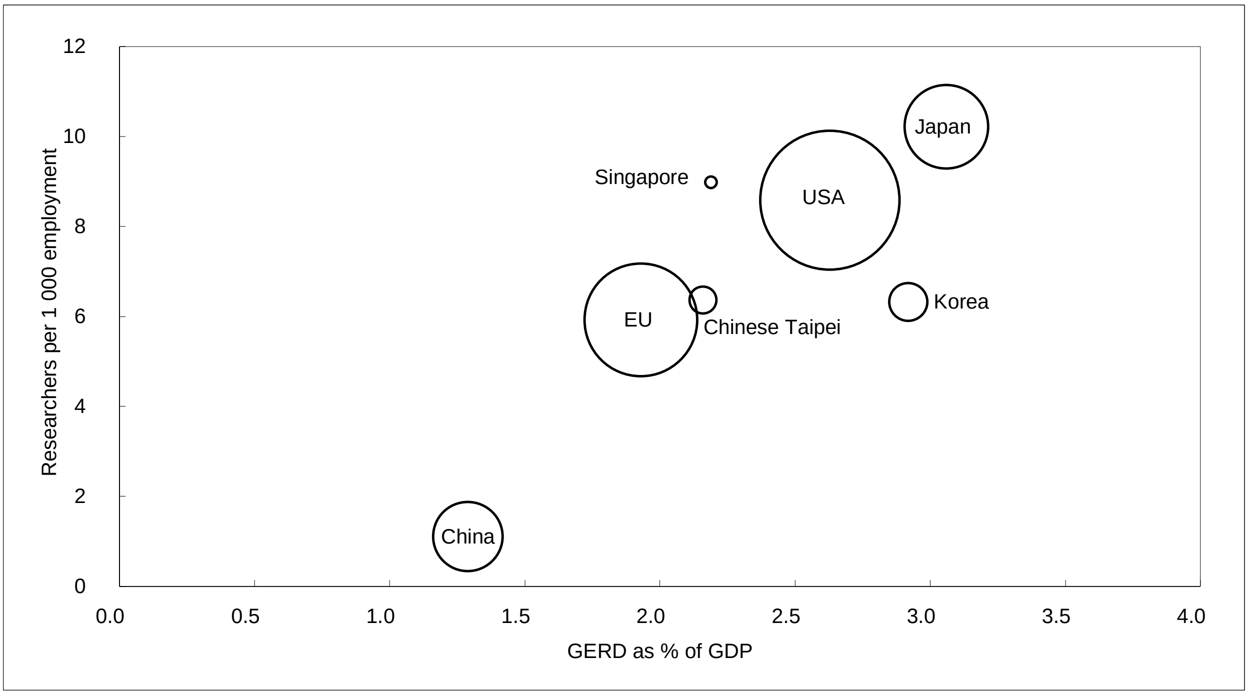


Notes: * There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional.

Source: OECD, MSTI database.

Figure 48 summarises the R&D efforts of various economies. The Y-axis in the figure relates to the number of researchers per 1 000 persons employed, while on the X-axis the R&D intensity is plotted. Finally, the size of the bubbles in the graph refers to the absolute level of R&D expenditure as expressed in current PPPs. Once again, for China this means that the size of bubble might be exaggerated. Otherwise, the figure shows that Japan is the leading economy in relative terms, ahead of the United States, which has the largest bubble, meaning that it has the largest absolute R&D expenditure. The three smaller Asian economies are positioned between the EU and the United States. Finally, despite the large absolute numbers, in relative terms, China is still far away from the R&D efforts in the other economies.

Figure 48. R&D efforts in selected economies, 2001



Notes: There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; the size of the bubble represents the amount of R&D expenditure in current PPPs.

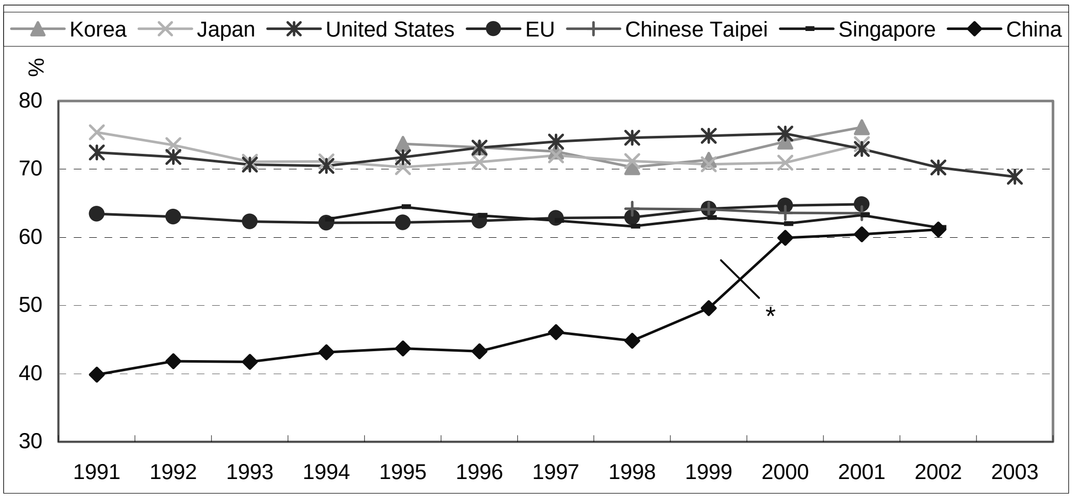
Source: OECD, MSTI database.

R&D by sector of performance

The R&D effort (expenditure and personnel) is usually broken down among four sectors of performance: business enterprise, higher education, government and private non-profit institutions serving households (PNP). This breakdown is largely based on the System of National Accounts, but higher education is viewed as a special sector, owing to the important role played by universities and similar institutions in the performance of R&D. Business enterprise R&D (BERD) covers R&D activities carried out in the business sector by performing firms and institutes, regardless of the origin of funding. As was stated before, industrial R&D is most closely linked to the creation of new products and production techniques.

Figure 49 shows that China's business R&D slowly increased from 40% to 45% of total GERD between 1991 and 1998, after which it shot up sharply to 61% in 2002. However, the sharp increase between 1999 and 2000 can largely be attributed to improved measurement methods (see Box 5), in particular the reclassification of government laboratories that have been privatised. The current level is not far behind that of the developed economies, and thus quite high for a developing economy.

Figure 49. R&D performed by the business enterprise sector, as a % of GERD



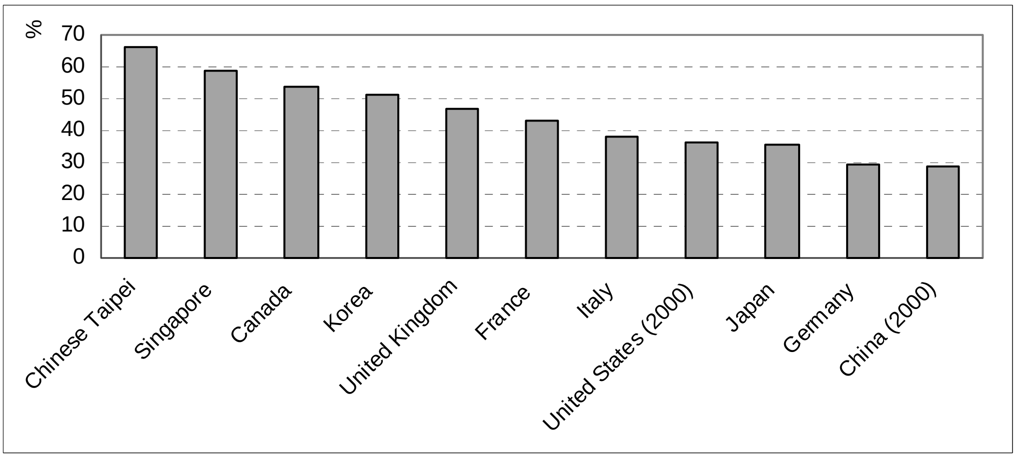
Notes: * There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional.

Source: OECD, MSTI database.

Concerning the other sectors of performance, what is noteworthy for China is the large proportion of R&D carried out by the government sector, which at 29% was much higher than in the other economies, where most of the remainder was performed by the higher education sector.

For many countries, it is possible to break down R&D in the business sector by specific industry. Using the technology-intensity classification of Box 2, Figure 50 shows the percentage of industrial R&D carried out in high-technology industries in 2001. For China (in 2000), this proportion was the lowest of the economies shown in the graph, although not very far behind the United States and Japan, but significantly less than in the other rapidly developing Asian economies.

Figure 50. R&D expenditure in high-technology industries as a % of total business enterprise R&D expenditure, 2001

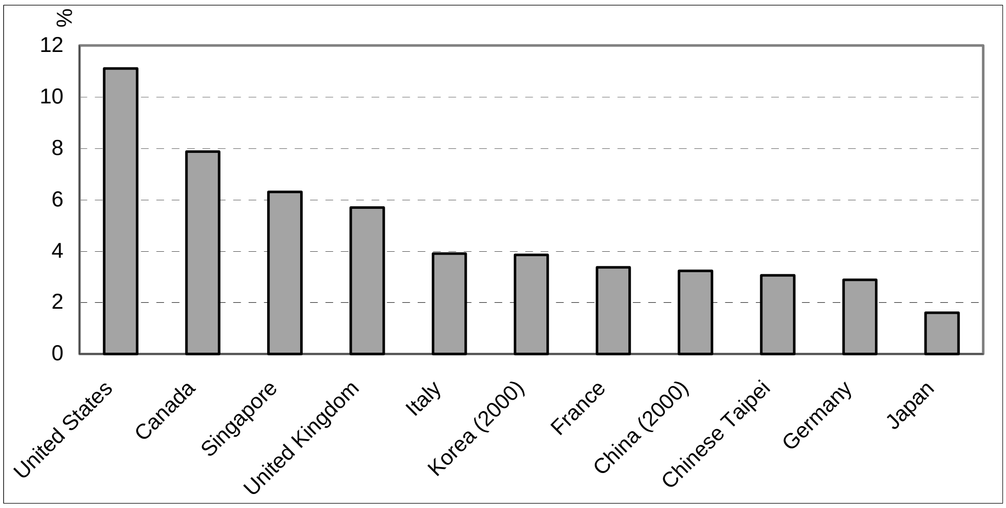


Note: See Box 5 for methodological notes.

Source: OECD, MSTI database.

There is insufficient detail available in the database to also show the percentage of business R&D carried out by knowledge-intensive market services, as defined in Box 2. However, it is possible to focus on a subset of these industries, that is ISIC Rev. 3 Division 72, computer and related activities - see Figure 51. In the United States, more than 11% of business research in 2001 was carried out by enterprises active in computer services. China's share (3.2%), although not very high, was close to the share of many other economies, ahead of big countries such as Germany and Japan.

Figure 51. R&D expenditure in computer services as a % of total business enterprise R&D expenditure, 2001



Note: See Box 5 for methodological notes.

Source: OECD, MSTI database.

R&D by source of finance

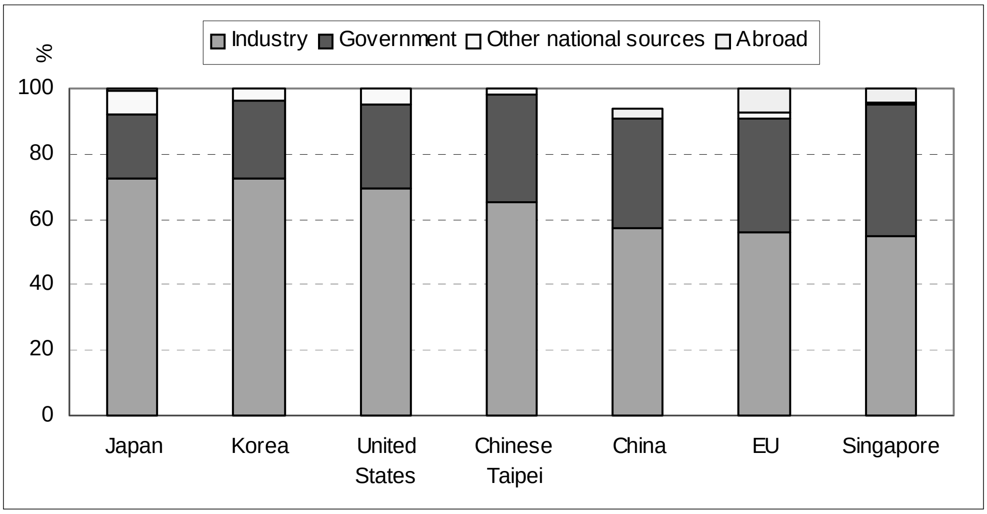
R&D has various sources of financing. Five are generally considered: the four R&D-performing sectors mentioned above and funds from "abroad". Flows of funds are measured using performance-based reporting on the funds received by one unit, organisation or sector from another unit, organisation or sector for the performance of intramural R&D. What is therefore measured are direct transfers of resources used to carry out R&D. Other government provisions to encourage R&D, such as tax concessions, the payment of bonuses for R&D, exemption from taxes and tariffs on R&D equipment, etc., are excluded. For purposes of international comparisons, public general university funds (GUF) are included in the sub-total for government funds. These are the funds allocated by higher education establishments to R&D from the general grant in support of their overall research and teaching activities which they receive from the Ministry of Education or the corresponding provincial or local authorities.

Considering that for China the sum of the sectors does not add up to 100[9], the proportion of industry financed R&D is roughly equal to the proportion of R&D carried out by industry (see Figure 52). The same holds for Japan and the United States, while in the EU more R&D is carried out by the business sector than

9. Until recently, in the Chinese classification system there were four sectors: government, higher education, business enterprise and the "other sector". The "other sector" in China is not the same as the PNP sector in OECD countries; some of the statistical units belong in the government, while others belong in the business enterprise sector. Data for the "other sector" have not been allocated to any of the sectors in Figure 52, which is why the sum of the elements does not add up to 100.

is financed by this sector. R&D financed from abroad is relatively high in the EU (7.2%), while it has some importance too for Singapore (4%) and China (2.7%).

Figure 52. R&D expenditure by sources of finance, 2000



Note: See Box 5 for methodological notes.

Source: OECD, MSTI database.

PATENTS

While R&D is one of the inputs of the innovation system, patents are one of the outputs, and patent indicators are one of the more traditional output indicators[10]. Patent-based indicators reflect the inventive performance of countries, regions, firms, and other aspects of the dynamics of the innovation process (co-operation in innovation, internationalisation of technology, etc.). Patent indicators, along with other science and technology indicators, thus contribute to our understanding of the innovation system and factors that support economic growth. For example, using the address of the inventors, indicators are developed to monitor the level of internationalisation and international collaboration of S&T activities.

Patent data are readily available from patent offices and contain much information (applicant, inventor, technology, claims, etc.). The choice of one date, among the set of dates included in patent documents, is important. The priority date (first filing worldwide) is the earliest and therefore closest to the invention date. Counts by application date introduce a bias owing to a one-year lag between residents and foreigners: the latter usually first file a patent application at their domestic office (the priority office) and later in other countries. To measure inventive activity, patent time series should be computed with respect to the priority date.

Like any other indicator, patents have certain weaknesses as indicators of technological performance. For instance, many inventions are not patented, and the propensity to patent differs across countries and industries. Another drawback is related to differences in patent regulations among countries, which hamper international comparability. Changes in patent law may also affect patent time series. Finally, the value distribution of patents is skewed: many patents have no commercial application (hence little value), while a few have great value. It is therefore important to rely on methods for counting patents that minimise statistical biases while conveying a maximum amount of information.

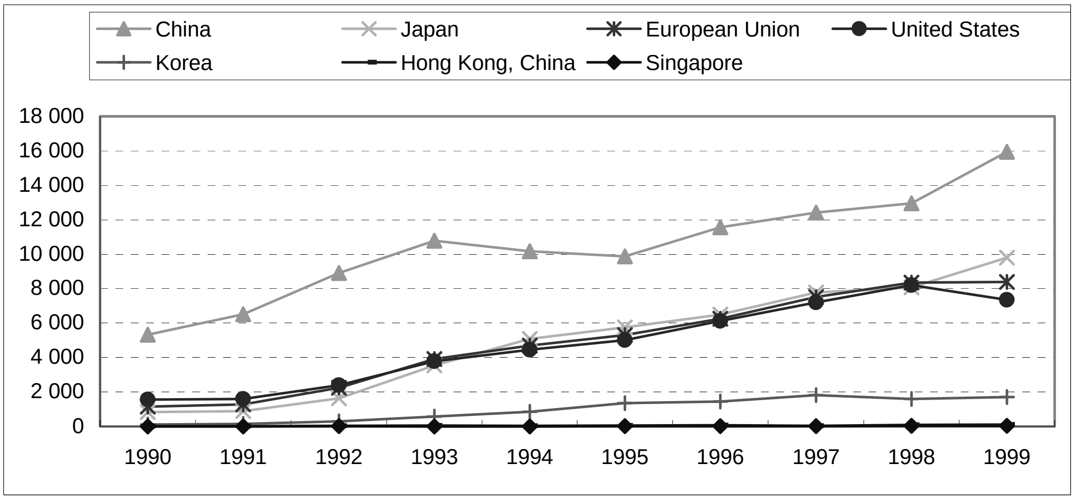
Patent applications to the Chinese patent office

The OECD collects and processes raw data from the European Patent Office (EPO), the Japanese Patent Office (JPO) and the US Patent and Trademark Office (USPTO) on a regular basis. The EPO supplies the OECD with the DocDB database, which includes patent records of a large number of national (and regional) patent office across the world, including the Chinese Patent Office (SIPO).

The level of patenting activity at the State Intellectual Property Office of the People's Republic of China (SIPO) increased rapidly during the 1990s (see Figure 53). The rapid increase in foreign patent applications is the main source of increase in total patent applications. Between 1990 and 1999, foreign patent applications increased by 26.9% a year, whereas domestic patent applications increased by 11.9% a year.

10. Patents are frequently viewed as an output indicator; however, they could also be viewed as an input indicator, as patents are used as a source of information by subsequent inventors.

Figure 53. Trend in patent applications to the SIPO, by residence of inventors

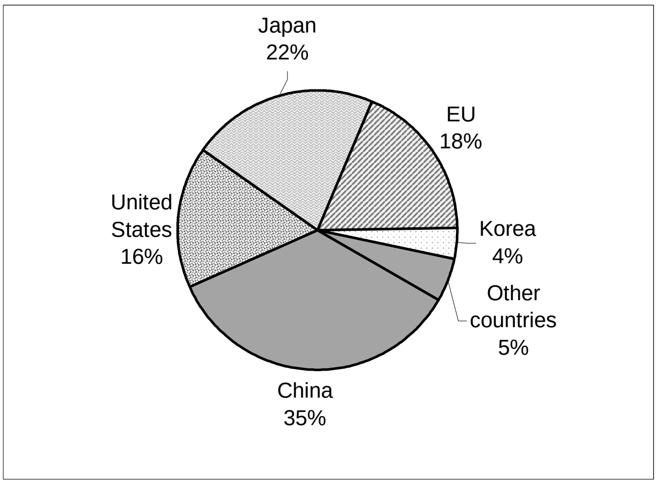


Note: Data are by priority year and are provisional.

Source: OECD, Patent Database, July 2003.

In 1999, 65% of the total number of patent applications to the SIPO – which amounted to 45 380 – were made by foreign inventors (see Figure 54). Japan accounted for 21.6% of total patent applications, followed by the EU (18.5%) and the United States (16.2%).

Figure 54. Share of countries in SIPO patents, 1999



Note: Data according to the residence of the inventors; data are by priority year and are provisional.

Source: OECD, Patent Database, July 2003.

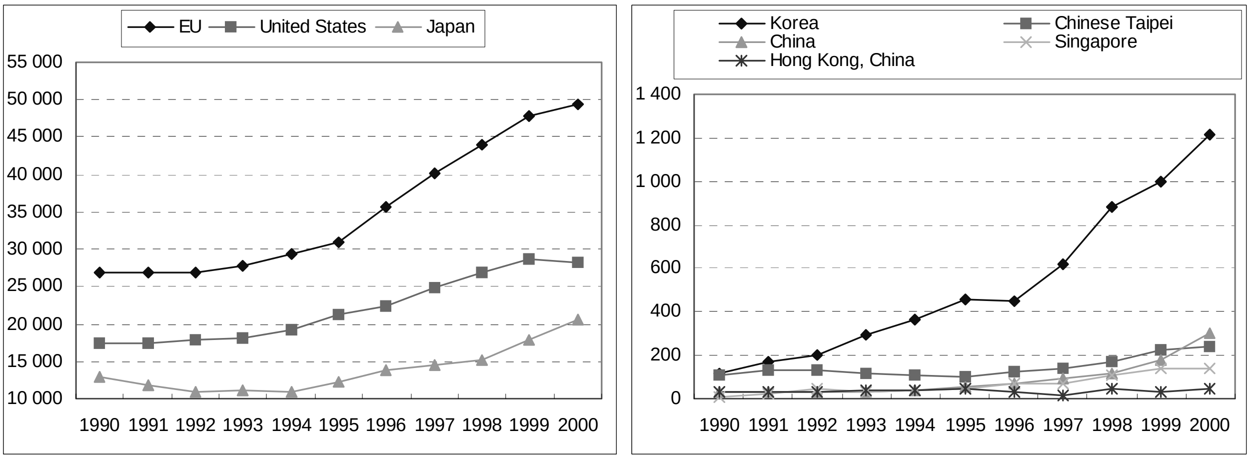
Patent applications to the EPO and granted by the USPTO

Patent applications or patent grants at the large patenting offices are commonly used indicators. Data from two of those databases are shown here, patents applications at the European Patent Office (EPO) and patents granted by the US Patent and Trademark Office (USPTO).

On the input side of innovation, as is shown for example by R&D indicators, China has been catching up rapidly in the last decade. On the output side, represented here by patent indicators, the situation is quite different, as can be seen in Figures 55 and 56.

The number of patents applied for by (at the EPO) or granted to (at the USPTO) Chinese inventors is small compared to the number of patents applied for by/granted to the other economies. Despite the fact that China registered strong growth since 1995, its contribution to the world total is still minor, accounting for around 0.2% and 0.3% of patent grants/applications at the USPTO/EPO, while the United States, Japan and the EU together accounted for around 90%.

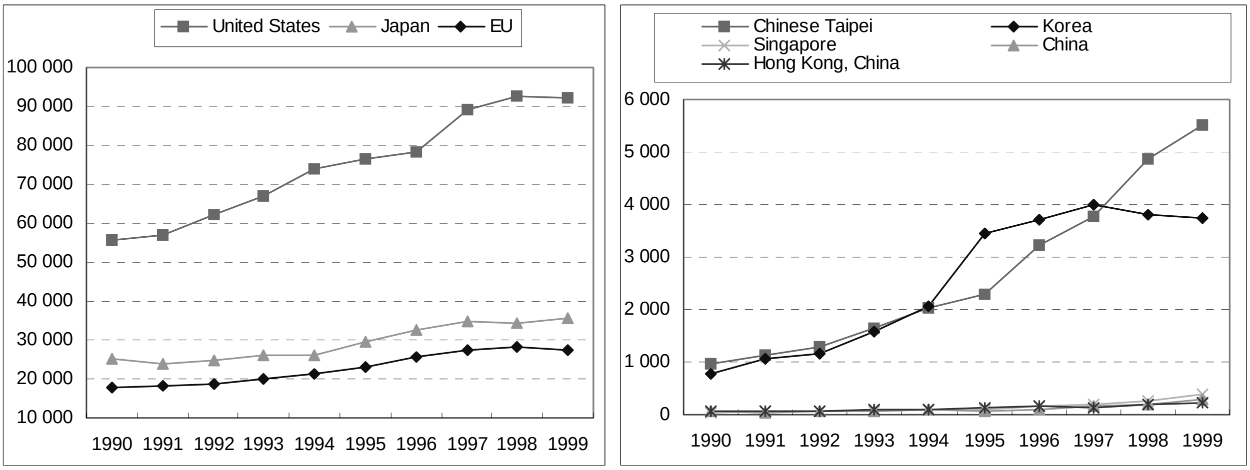
Figure 55. Number of patent applications at the EPO, by residence of inventors



Note: data are by priority year and data for 1999 and 2000 are provisional.

Source: OECD, Patent Database, November 2003.

Figure 56. Number of patents granted by the USPTO, by residence of inventors



Note: Data are by priority year; data for 1997 are provisional, data for 1998 and 1999 are estimated.

Source: OECD, Patent Database, November 2003.

Patent families

A common approach is to calculate patent indicators based on information (filings, grants, etc.) from a particular patent office. While the richness and strength of those indicators are broadly recognised, they are affected by "home" advantage bias – where proportionate to their inventive activity, domestic applicants tend to file more patents in their home country compared to foreign applicants. At the SIPO, China accounts for the largest number of patents, at the EPO, the EU has the largest share, while at the USPTO the United States is the dominant country. Another weakness of patent applications at national patent offices is the highly heterogeneous value of the patents.

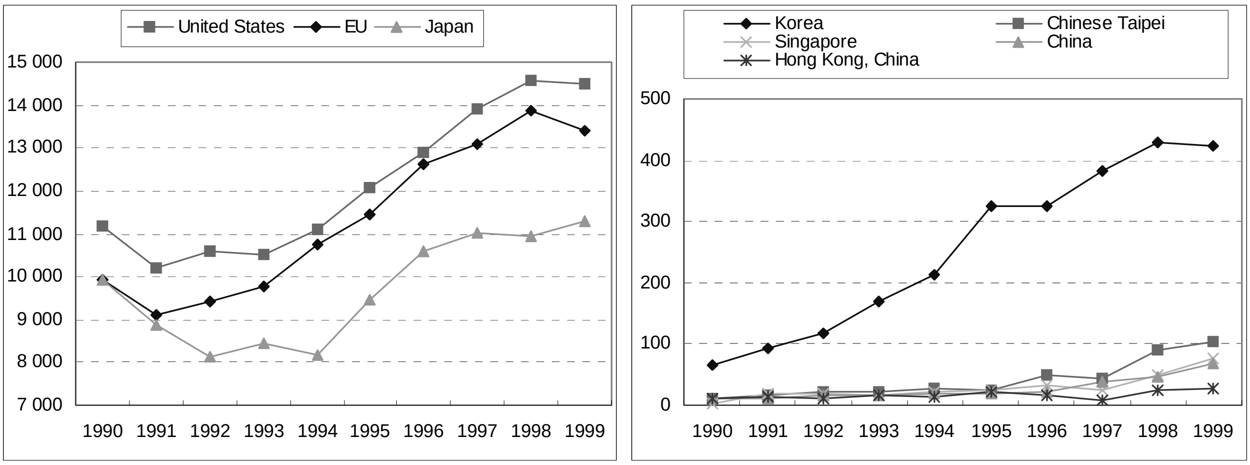
The OECD has developed a set of indicators based on patent families which corrects for this weakness of traditional patent indicators. A patent family is defined as a set of patents taken in various countries to protect a single invention. The OECD triadic patent families indicator relates to patents applied for at the European Patent Office (EPO) and the Japanese Patent Office (JPO) and patents granted by the US Patent & Trademark Office (USPTO); the patents from these offices are linked by priority date to form patent families.

Patent families improve international comparability of patent-based indicators. Inventors usually take a patent first in their home country and may later file patents abroad. Patent families concern patenting at this set of patent offices. The "home advantage" is suppressed as the measures are no longer affected by the region in which patents are taken (a country generally takes more patents in its domestic market than in other regions).

To be a member of a patent family, a patent must be filed in several countries and in doing so the patentee takes on additional costs to extend protection to other countries only if it seems worthwhile to do so. Thus, patents that are members of families will generally be of higher value than those filed in a single country.

The result for patent families is the same as for EPO and USPTO patents: despite a strong growth between 1996 and 1999, China accounts for less than 0.2% of the world total, while the United States, the EU and Japan together account for more than 90% of the world total (see Figure 57).

Figure 57. Number of "triadic" patent families, by residence of inventors



Note: Data are by priority year; data for 1997 are provisional, data for 1998 and 1999 are estimated.

Source: OECD, Patent Database, November 2003.

When population is taken into account, China lags even further behind, with 0.1 patent family per million population in 1999. This is a very small number, compared with 89 for Japan, 52 for the United States and 36 for the EU. The other Asian economies are also lagging behind, with between 4 families for Hong Kong, China and 19 for Singapore.

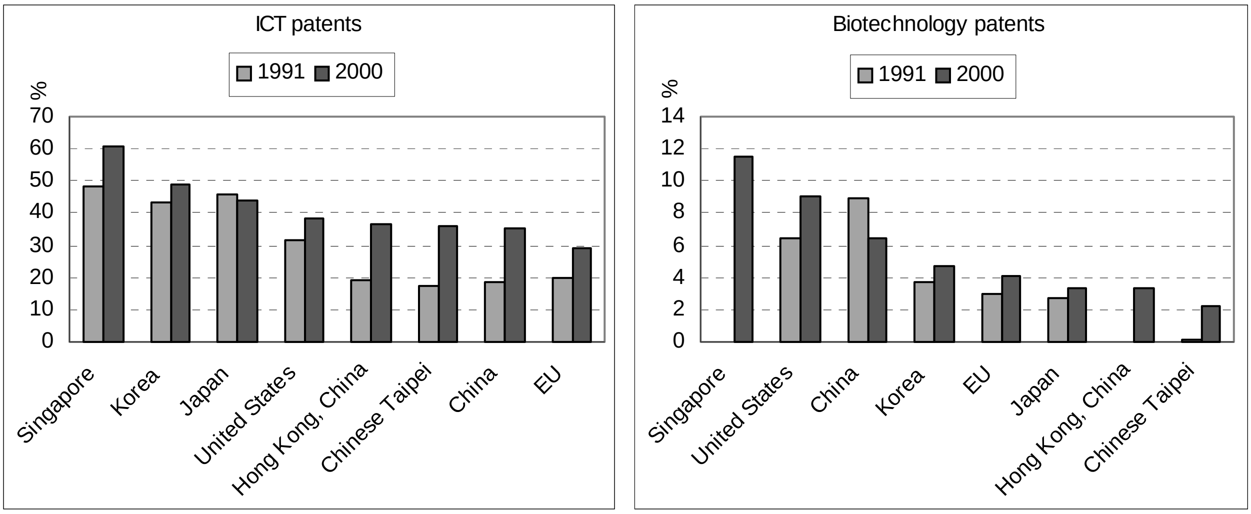
ICT and biotechnology patents

Information and communication technologies (ICTs) have undoubtedly been one of the main drivers of economic growth in the last decade, and will remain of crucial importance in the future. The ICT sector invests heavily in R&D and is highly innovative. An indication of the innovativeness of this industry is given by the proportion of patents that are ICT-related. The provisional definition of ICT-related patents used here to calculate ICT-related patents is very broad and covers a wide range of classes of the International Patent Classification (IPC).

It is generally accepted that the application of biotechnological processes is also becoming an important driver of economic development in the developed as well as the developing world, particularly for selected sectors in some countries, and this role is expected to grow. The OECD has worked towards developing statistics on biotechnology patents[11].

In 2000, 35% of all patents applied at the EPO were ICT-related, up from 28% in 1991. Singapore was well above this mark, with 61% of ICT-related patents as a share of total patents in 2000 (see Figure 58). The shares of Korea (49%) and Japan (44%) were also significantly higher than the average. This last country, however, was the only one to see its share drop during the 1990s. China's share overtook the EU's share during the 1990s. It has to be kept in mind, however, that the absolute numbers for China are incomparable with the absolute numbers for the EU.

Figure 58. Countries' patent applications at the EPO that are in the ICT or biotechnology fields as a share of those countries' total patent applications at the EPO



Note: Data are by priority year and data for 2000 are provisional.

Source: OECD, Patent Database, November 2003.

11. For the definitions of ICT-related and biotechnology-related patents, see the *Compendium of Patent Statistics* (OECD, 2003a).

Biotechnology does not reach the heights of ICT, but – like ICT – saw its share increase during the 1990s, from 4% in 1991 to 5.5% in 2000. As for ICT, Singapore was well above this score with a ratio of 11.5% of biotechnology patents to total patents applied at the EPO in 2000. China's share dropped from 9% in 1991 to 6.4% in 2000, while the United States' share increased from 6.4% to 9%.

Cross-border ownership of inventions

Patents are increasingly recognised as a rich source of information about technological performance. Patent files show the inventor and the applicant (the owner of the patent at the time of application), their addresses and hence their country of residence. For most patents, the applicant is an institution (generally a firm, university or public laboratory), and sometimes an individual, but inventors are always individuals.

An increasing share of European Patent Office (EPO) patent applications is controlled by applicants whose country of residence is different from the country of residence of the inventor(s). Cross-border ownership practices are mainly the result of activities of multinationals; the applicant is a conglomerate and the inventors are employees of a foreign subsidiary. It is therefore possible to trace the international circulation of knowledge from "inventor" countries to "applicant" countries. Such information can be used to compute two main types of indicators:

- The first evaluates the extent to which foreign firms control domestic inventions by dividing the number of domestic inventions controlled by a foreign resident by the total number of domestic inventions.

- The second provides a mirror image: it evaluates the extent to which domestic firms control inventions made by residents of other countries. The number of foreign inventions controlled by resident applicants is divided by the total number of domestic applications. For example, a multinational from country A has research facilities in both country A and country B. This indicator provides the share of patents from its facilities in country B in the total number of patents.

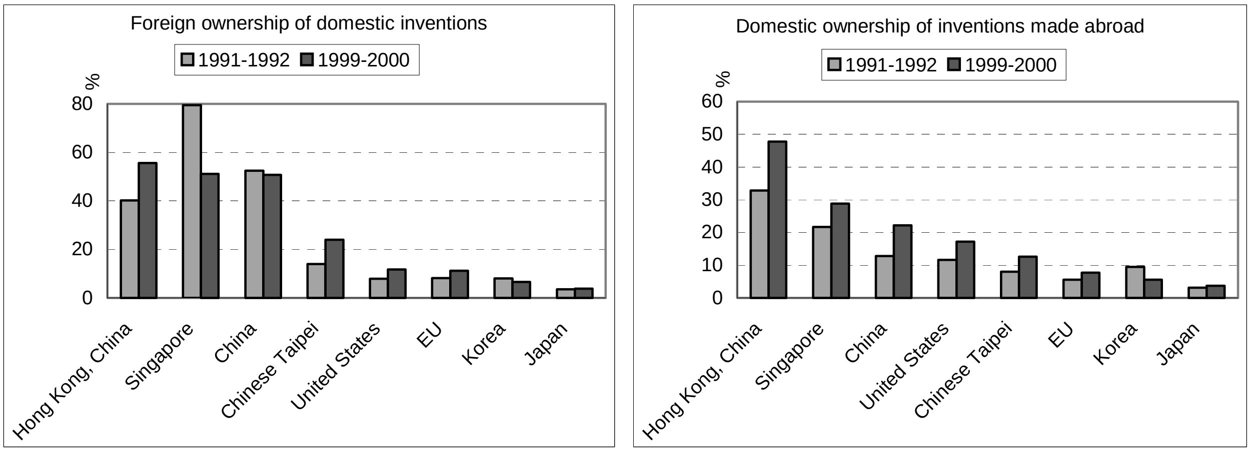
The analysis is based on the database of patent applications to the EPO. Patents granted by the United States Patent & Trademark Office (USPTO) show similar internationalisation trends.

As firms progressively relocate their production and research facilities abroad as part of their internationalisation strategies, an increasing share of technology is owned by firms of a country that is not the inventor's country of residence. The left-hand graph of Figure 59 shows that foreign ownership of domestic inventions is high in China, Singapore and Hong Kong, China, where more than 50% of total inventions filed at the EPO are owned (or co-owned) by a foreign resident (either a person or a firm). A high share of foreign ownership of domestic inventions is also observed for Chinese Taipei. Japan and Korea, on the other hand, are much less internationalised in terms of cross-border ownership of inventions; less than 10% of total inventions (filed at the EPO) are foreign-owned. In the case of Japan and Korea, a possible explanation for the low share of foreign ownership of domestic inventions are linguistic barriers, low penetration of foreign affiliates and geographical distance from Europe and the United States.

In the case of China, 46.6% of the foreign (co-)owned patents were held by US institutions. Almost 28% were located in the EU, while Japan and Hong Kong, China both accounted for slightly less than 6%.

The right hand graph of Figure 59 shows that the domestic ownership of inventions made abroad is high in small open economies such as Singapore and Hong Kong, China. This is party explained by the presence of headquarters of firms which conduct most of their research activity abroad. In terms of absolute numbers, the United States and the EU are the largest owners of inventions made abroad. However, these countries also have a large total patent portfolio (inventions made at home and abroad), which is the reason for the low share of foreign invention in total patent portfolio. Japan and Korea seem to be less internationalised with respect to ownership of inventions made abroad.

Figure 59. Foreign ownership of domestic inventions[1] and domestic ownership of inventions made abroad[2]



Notes:

1. Share of patent applications to the EPO owned by foreign residents in total patents invented domestically.

2. Share of patent applications to the EPO invented abroad in total patents owned by country residents.

Data are according to the residence of the inventors; average for two priority years. The EU is treated as one country; intra-EU co-operation is excluded.

Source: OECD, Patent Database, November 2003.

The most important Chinese partner economies were the United States, where China held 32% of its inventions owned or co-owned abroad, followed by the EU (25%), Hong Kong, China (16.5%) and Japan (9%).

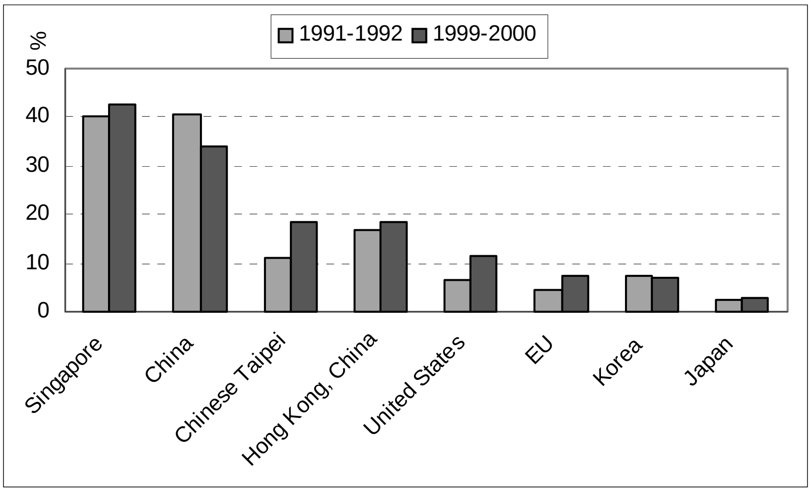
International co-operation in science and technology

Patent data include the name and address of all inventors (individuals). An increasing share of European Patent Office (EPO) patent applications involves inventors with different countries of residence. International collaboration by researchers can take place either within a multinational corporation (research facilities in several countries) or through a research joint venture among several firms.

The propensity to collaborate internationally can be derived from the address of the inventors listed in the patent file. Here, it is approximated as the ratio of the number of inventions involving a country's residents and at least one inventor with foreign residence to the total number of inventions involving a country's residents. An increasing share of patents involves inventors with residences in more than two countries.

The co-inventions of patents provide an indication of the level of internationalisation of scientific and technological activities. Internalisation tends to be higher in non-OECD economies than in OECD member countries. For example, 43% of Singapore's patents have foreign co-inventors, and in China around one-third of patents are co-invented (see Figure 60). The share of patents with foreign co-inventors in Chinese Taipei (18.6%) and Hong Kong, China (18.5%) as well are above those of Japan (2.9%), Korea (6.8%), the EU (7.3%), and the United States (11.3%). For a majority of countries, the share of patents with foreign co-inventors is higher in the late 1990s compared to the early 1990s, with China as a notable exception.

Figure 60. Percentage of patents with foreign co-inventors[1] at the EPO



Notes:

1. Share of patent applications to the EPO with at least one foreign co-inventor in total patents invented domestically.

Data are an average for two priority years. The EU is treated as one country; intra-EU co-operation is excluded.

Source: OECD, Patent Database, November 2003.

The United States was China's most important partner country with almost half of the Chinese co-inventions. The EU accounted for 40% and Japan only for 7%.

CONCLUSIONS

Economic development and economic restructuring form the core subject of China's Tenth Five-Year Plan (2001-05). Among the goals set in this ambitious plan are a strengthening of R&D financing, improvement of enterprise R&D and the development of high-technology industries. The indicators presented in this paper have shown that China is making great strides in reaching (at least some of) these targets.

Economic growth has been impressive over the last decade, averaging almost 10% per year in real terms, outpacing the other dynamic Asian economies by 4 to 6 percentage points, and the Triad economies – the United States, the EU and Japan – by 7 to 8 percentage points every year. Nevertheless, GDP per capita is still substantially lower than that of the other economies. Furthermore, whereas in developed economies gross value added is usually for at least two-thirds generated in services, in China this is only one-third. Instead, the main contributor to GDP in China is industry, which saw its share rising by 10 percentage points to 52% between 1990 and 2002, at the expense of agriculture, of which the share shrank to 14.5%. This was, however, still substantially higher than the share of the developed economies, indicating the still large rural population in China.

During the 1990s, China has been opening up to the rest of the world. Trade indicators support this statement. Trade in goods as a percentage of GDP doubled between 1990 and 2002, reaching a level well above that of the Triad economies. The largest contribution to this expansion was made by high-technology industries, both in imports and exports, underlining China's desire to develop these industries. High-technology exports (measured in constant 1995 USD) grew by almost 22% annually between 1992 and 2001, which is 2 to 3 times higher than the growth rates of the other economies (with the exception of Japan, with an average annual growth rate of -0.2%). However, despite the surge in exports of high-technology goods, China still has a strong comparative advantage in low-technology industries.

Half of China's high-technology exports in 2001 consisted of radio, TV and communications equipment, while more than one-third was made up by computers and office machinery. This last category rapidly increased in importance during the 1990s, growing by more than 2 000% (in current USD) since 1992. Focusing on ICT goods only, 59% of Chinese imports in 2001 consisted of electronic components, while 78% of its exports concerned computer, telecommunications, audio and video equipment. This gives rise to the notion of China as an importer of ICT components for assembly in China, after which the finalised products are exported back to the rest of the world, some of it to the mother company as intra-firm exports. The main consumers of China's high-technology exports are the United States, which accounted for 27% of China's high-technology manufacturing exports in 2001, followed by the EU at 24% and Japan at 13%.

Another indication of the opening up of the Chinese economy is provided by foreign direct investment. With almost USD 50 billion of inflows, China was the world's largest recipient of FDI in 2002. Whereas in other countries, in particular the United States, Germany and the United Kingdom, FDI inflows plunged after reaching record levels in 2000, inflows in China increased steadily, without any noteworthy drop after the turn of the millennium.

Foreign affiliates in China of multinational enterprises located in Japan, the United States and Germany generated low turnover per employee, when compared with foreign affiliates in Singapore, Hong

Kong, China or Chinese Taipei, which points to a tentative conclusion that multinationals are using China for the production of low-technology goods.

Human resources are crucial in developing an increasingly knowledge-based economy. Only a very small part of the population in China has a tertiary education degree, but because of the enormous population base where these people can be drawn from, it nevertheless amounts to a substantial number, providing China with one of the essential elements in developing and upgrading its economy. Although still low in relative terms, the absolute number of enrolments in, and graduates from, tertiary education in China match the numbers in the United States and the EU, assuring a continuous inflow of skilled people in the labour market. However, at the highest level – meaning enrolments in and graduation from advanced research programmes, such as PhDs – China's level is still low compared to the other economies.

A substantial number of Chinese students enrol in OECD countries, half of them in the United States. Furthermore, a quarter of the doctorates in science and engineering in the United States awarded to non-US citizens were given to Chinese citizens. If at some point in their lives, these students and PhD holders return to China, they have the potential to give a great impetus to research in China. Even without return migration, there has been a huge expansion in the number of researchers in China since 1999. China counts now more researchers than Japan, and is on its way to potentially overtake the EU as well.

The amount of money spent on R&D has increased even faster than the researchers base. Due to uncertainty about the proper conversion rate to apply, it is difficult to compare the absolute level of R&D expenditure with other economies, although China will certainly rank in the top-10 worldwide. In relative terms, China is still far away from the developed economies, although the R&D intensity has been rising rapidly. At 1.3% in 2002, China seems poised to reach its target of spending 1.5% of GDP on R&D in 2005.

While the inputs into the innovation process, such as human resources and R&D expenditure, have been growing quickly over the last decade and are moving closer to the standards in the developed world, on the output side, at least concerning patents, China is moving much slower. Despite the fact that China has registered strong growth since 1995, its share in the US Patent and Trademark Office and European Patent Office patents is still small, accounting for around 0.2% and 0.3% of patent grants/applications at the USPTO/EPO, while the United States, Japan and the EU together accounted for around 90%. The level of international co-operation in science and technology turns out to be higher for China than for the Triad economies.

BIBLIOGRAPHY

Bai, M., R. Ren and A. Szirmai (2002), How Productive is Chinese Manufacturing? Comparative Labour Productivity in Chinese Manufacturing, 1980-1999, *27th general Conference of the International Association for Research in Income and Wealth*, Stockholm, Sweden, August 18-24, 2002.

Balassa, B. (1964), "The Purchasing Power Parity Doctrine: A Reappraisal", *Journal of Political Economy 72*, pp. 584-596.

Dahlman, C. and J.E. Aubert (2001), *China and the Knowledge Economy: Seizing the 21st Century*, World Bank Institute, Washington, DC.

Heston, Alan, Robert Summers and Bettina Aten (2002) *Penn World Table Version 6.1*, Center for International Comparisons at the University of Pennsylvania (CICUP).

Maddison, A. (1998), *Chinese Economic Performance in the Long Run*, OECD Development Centre, Paris.

Maddison, A. (2001), *The World Economy: A Millennial Perspective*, OECD Development Centre, Paris.

National Bureau of Statistics (NBS) (2002), *China Statistical Yearbook 2001*, China Statistical Press, Beijing.

National Science Foundation (NSF) (2002), Science and Engineering Indicators–2002, NSF, Arlington, VA.

OECD (Organisation for Economic Co-operation and Development) (2001), *Thematic Review of the First Years of Tertiary Education. Country Note: People's Republic of China*, CCNM/CHINA/DEELSA(2001)1.

OECD (2002a), *China in the World Economy. The Domestic Policy Challenges*, OECD, Paris.

OECD (2002b), *The Measurement of Scientific and Technological Activities. Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, Paris.

OECD (2002c), "Science and Technology in China: Trends and Policy Challenges", *OECD Science, Technology and Industry Outlook 2002*, OECD, Paris, pp. 247-276.

OECD (2003a), *Compendium of Patent Statistics*, OECD, Paris.

OECD (2003b), *Education at a Glance; OECD indicators 2003*, OECD, Paris.

OECD (2003c), *International Investment Perspectives 2003*, OECD, Paris.

OECD (2003d), *Main Science and Technology Indicators 2003/2*, OECD, Paris.

OECD (2003e), *OECD Science, Technology and Industry Scoreboard 2003*, OECD, Paris.

OECD (2003f), *OECD Statistics on International Trade in Services 1992-2001*, OECD, Paris.

OECD (2003g), "A Proposed Classification of ICT Goods", Working Party on Indicators for the Information Society, DSTI/ICCP/IIS(2003)1/REV2, http://www.oecd.org/dataoecd/5/61/22343094.pdf.

Ren, R. (1997), *China's Economic Performance in an International Perspective*, OECD Development Centre, Paris.

Samuelson, P.A. (1964), "Theoretical Notes on Trade Problems", *Review of Economics and Statistics 23*, pp. 145-154.

ANNEX I: STATISTICAL ANNEX

List of tables:

Table SA 1: Population (millions)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	1143	1158	1172	1185	1199	1211	1224	1236	1248	1259	1266	1276	1295
European Union	364	365	367	369	370	371	372	373	374	375	376	378	379
Hong Kong, China	6	6	6	6	6	6	6	6	7	7	7	7	7
Japan	124	124	124	125	125	126	126	126	126	127	127	127	127
Korea	43	43	44	44	45	45	46	46	46	47	47	47	48
Singapore	3	3	3	3	3	4	4	4	4	4	4	4	4
Chinese Taipei	20	20	21	21	21	21	21	22	22	22	22	22	22
United States	250	253	255	258	261	263	266	268	271	273	275	286	289

Sources: OECD, Main Economic Indicators database and IMF, International Financial Statistics.

Table SA 2: Gross Domestic Product (billions of national currency)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
China	1855	2162	2664	3463	4676	5848	6788	7446	7835	8205	8940	9593	9961	
European Union														
Hong Kong, China	588	677	791	913	1030	1096	1211	1345	1280	1246	1288	1270	1260	
Japan	442	470	482	486	492	499	512	523	517	509	513	507	501	495
Korea	179	217	246	277	323	377	418	453	444	483	522	552	596	631
Singapore	67	75	81	94	108	119	130	142	137	138	158	152	156	
Chinese Taipei	4307	4811	5339	5918	6464	7018	7678	8329	8939	9290	9663	9507	9749	9880
United States	5751	5931	6262	6583	6993	7338	7751	8257	8720	9213	9762	10020	10383	10810

Note: Trillions of national currency for Japan and Korea.

Sources: OECD, National Accounts and Main Economic Indicators databases; Eurostat NewCronos database; World Bank, World Development Indicators; IMF, International Financial Statistics; and OECD, based on national sources.

Table SA 3: Gross Domestic Product (billions of current PPP $)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
China	1512	1694	2009	2326	2666	3088	3414	3712	3972	4349	4842	5259	5576	
European Union	5631	6038	6427	6474	6809	7255	7499	7990	8337	8735	9304	9711	9933	10222
Hong Kong, China	94	102	113	118	128	136	146	152	141	148	171	171	178	
Japan	2264	2434	2564	2639	2724	2936	3091	3209	3082	3142	3298	3390	3441	3532
Korea	318	360	389	420	464	517	562	602	566	639	714	754	811	866
Singapore	37	41	44	52	58	64	71	75	75	82	95	93	97	
Chinese Taipei	226	249	278	304	332	365	392	419	436	469	505	506	532	552
United States	5751	5931	6262	6583	6993	7338	7751	8257	8720	9213	9762	10020	10383	10810

Sources: OECD, National Accounts and Main Economic Indicators databases; Eurostat NewCronos database; World Bank, World Development Indicators; IMF, International Financial Statistics; and OECD, based on national sources.

Table SA 4: Gross Domestic Product (billions of constant 1995 national currency)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
China	3321	3626	4141	4700	5292	5848	6409	6973	7517	8050	8691	9330	10076	
European Union		6220	6298	6269	6442	6595	6701	6867	7068	7270	7529	7653	7731	7779
Hong Kong, China	827	874	932	991	1045	1086	1133	1190	1131	1169	1288	1294	1324	
Japan	463	478	483	485	489	499	516	525	520	520	535	537	539	544
Korea	263	288	303	320	346	377	403	423	395	438	479	493	525	552
Singapore	77	83	88	99	110	119	129	140	138	147	161	157	161	
Chinese Taipei	4976	5352	5753	6157	6594	7018	7446	7943	8306	8757	9270	9067	9393	9680
United States	6520	6488	6687	6866	7146	7338	7603	7943	8286	8629	8955	8978	9196	9422

Notes: Trillions of national currency for Japan and Korea; data for Hong Kong, China are in constant 2000 national prices.

Sources: OECD, National Accounts and Main Economic Indicators databases; Eurostat NewCronos database; World Bank, World Development Indicators; IMF, International Financial Statistics; and OECD, based on national sources.

Table SA 5: Share of agriculture in gross value added (based on current prices) (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	27.1	24.5	21.8	19.9	20.2	19.7	20.2	18.6	18.0	17.3	16.0	15.2	14.5
European Union	3.2	3.0	2.8	2.7	2.7	2.7	2.7	2.5	2.4	2.3	2.1	2.1	2.0
Hong Kong, China								0.1			0.1	0.1	
Japan	2.4	2.2	2.1	1.9	2.0	1.8	1.8	1.5	1.5	1.4	1.3	1.3	
Korea	8.5	7.6	7.4	6.7	6.5	6.1	5.8	5.3	4.9	5.0	4.7	4.3	3.9
Singapore									0.1	0.1	0.1	0.1	0.1
Chinese Taipei	4.1	3.7	3.5	3.6	3.4	3.4	3.1	2.5	2.4	2.5	2.0	1.9	1.8
United States	1.9	1.7	1.8	1.7	1.7	1.5	1.7	1.6	1.5	1.4	1.4	1.4	

Notes: Agriculture is composed of agriculture, hunting and forestry; and fishing (ISIC Rev. 3 01 to 05); composition of GDP instead of gross value added for China and the United States.

Sources: OECD, National Accounts and Main Economic Indicators databases; Eurostat, NewCronos database; and OECD, based on national sources.

Table SA 6: Share of industry in gross value added (based on current prices) (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	41.6	42.1	43.9	47.4	47.9	49.1	49.4	50.0	49.2	49.7	50.8	51.1	51.7
European Union	32.8	31.9	31.0	29.8	29.7	29.8	29.2	28.9	28.5	28.0	27.9	27.5	26.9
Hong Kong, China								14.7			14.2	13.3	
Japan	38.1	37.7	36.4	34.9	33.5	32.8	32.6	32.3	31.3	31.0	31.0	29.4	
Korea	43.3	44.3	43.1	43.2	42.7	42.9	42.7	42.9	43.4	42.3	42.4	41.8	40.3
Singapore									35.4	34.2	36.2	33.3	34.8
Chinese Taipei	40.5	40.2	39.2	38.5	36.8	35.4	34.7	34.1	33.3	31.9	31.2	29.7	29.6
United States	27.4	26.2	25.5	25.4	25.8	25.7	25.3	24.8	24.2	24.0	23.6	22.3	

Notes: Industry consists of mining and quarrying; manufacturing; electricity, gas and water supply; and construction (ISIC Rev. 3 10 to 41); composition of GDP instead of gross value added for China and the United States.

Sources: OECD, National Accounts and Main Economic Indicators databases; Eurostat, NewCronos database; and OECD, based on national sources.

Table SA 7: Share of services in gross value added (based on current prices) (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	31.3	33.4	34.3	32.7	31.9	31.2	30.4	31.3	32.8	32.9	33.2	33.6	33.7
European Union	64.0	65.1	66.2	67.6	67.6	67.6	68.1	68.6	69.1	69.7	70.0	70.4	71.1
Hong Kong, China								85.2			85.7	86.6	
Japan	59.5	60.1	61.5	63.2	64.4	65.4	65.7	66.1	67.1	67.5	67.7	69.2	
Korea	48.2	48.1	49.5	50.1	50.8	51.0	51.5	51.8	51.7	52.7	52.9	53.9	55.8
Singapore									64.5	65.7	63.7	66.6	65.1
Chinese Taipei	55.4	56.0	57.2	57.9	59.8	61.2	62.2	63.5	64.3	65.7	66.8	68.4	68.7
United States	70.7	72.0	72.7	72.9	72.5	72.8	73.0	73.6	74.3	74.6	75.1	76.3	

Notes: Services are composed of wholesale and retail trade; hotels and restaurants; transport, storage and communications; financial intermediation; real estate, renting and business activities; public administration and defence; compulsory social security; education; health and social work; other community, social and personal service activities; private households with employed persons; and extra-territorial organizations and bodies (ISIC Rev. 3 50 to 99); composition of GDP instead of gross value added for China and the United States.

Sources: OECD, National Accounts and Main Economic Indicators databases; Eurostat, NewCronos database; and OECD, based on national sources.

Table SA 8: Trade in goods as a share of GDP[1] (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	12.2	13.6	14.3	13.5	18.3	17.0	17.2	17.7	16.8	17.7	21.5	20.9	24.5
European Union	7.9	7.7	7.4	8.0	8.5	8.7	9.0	9.7	9.6	9.7	11.6	11.4	
Hong Kong, China									108.8	109.8	125.0	119.8	125.6
Japan	8.1	7.5	7.1	6.5	6.5	6.9	7.6	8.3	7.9	7.6	8.4	8.4	8.7
Korea	25.7	25.0	24.5	23.4	23.9	25.9	26.4	29.4	35.1	32.3	36.3	33.8	32.6
Singapore	150.2	142.3	135.4	136.1	137.9	143.4	137.4	133.2	125.6	135.5	145.8	137.8	136.9
Chinese Taipei	38.0	39.0	36.2	36.3	36.8	40.9		36.1	42.3	40.6		41.5	
United States	7.6	7.6	7.7	7.9	8.3	9.0	9.1	9.4	9.1	9.3	10.2	9.3	8.9

Notes: 1. Average of imports and exports as a share of nominal GDP.

Data for the EU exclude intra-EU trade.

Sources: OECD, National Accounts and ITCS databases; IMF, Balance of Payments Statistics; and OECD, based on national sources.

Table SA 9: Trade in services as a share of GDP[1] (%)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	1.3	1.4	2.0	1.9	3.0	3.2	2.6	2.9	2.6	2.9	3.1	3.0	3.5
European Union	2.8	2.7	2.5	2.6	2.7	2.6	2.8	3.1	3.0	3.1	3.4	3.5	
Hong Kong, China									18.2	18.6	19.8	20.2	21.5
Japan	2.1	1.9	1.9	1.7	1.7	1.8	2.1	2.2	2.2	2.0	2.0	2.1	2.2
Korea	3.9	3.8	3.9	4.1	4.4	5.0	5.1	5.9	7.9	6.6	6.9	7.2	6.7
Singapore	29.0	26.6	25.8	25.7	26.2	29.7	28.5	27.0	25.3	30.8	30.6	32.8	32.8
United States	2.3	2.4	2.3	2.3	2.4	2.4	2.5	2.5	2.6	2.5	2.6	2.4	2.5

Notes: 1. Average of imports and exports as a share of nominal GDP.

Data for the EU exclude intra-EU trade.

Sources: OECD, National Accounts database; and IMF, Balance of Payments Statistics.

Table SA 10: Chinese manufacturing imports by technological intensity (billions of USD)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
High-technology manufactures	12.5	15.9	20.1	21.6	22.7	26.4	32.6	42.8	59.4	70.2
Medium-high technology manufactures	32.5	41.1	46.3	52.4	55.3	50.7	48.8	55.2	69.3	77.4
Medium-low-technology manufactures	11.4	22.4	19.6	18.9	19.8	21.3	21.4	24.2	31.8	32.8
Low-technology manufactures	15.8	16.3	21.0	26.1	27.1	27.9	26.0	27.6	32.6	32.0

Source: OECD, ITCS database.

Table SA 11: Chinese manufacturing exports by technological intensity (billions of USD)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
High-technology manufactures	9.3	10.7	15.6	21.5	24.3	30.0	34.7	40.2	55.8	64.4
Medium-high technology manufactures	10.8	12.4	16.6	23.6	24.4	29.0	31.4	35.3	47.3	51.5
Medium-low-technology manufactures	9.5	9.5	13.4	21.5	20.5	26.3	25.7	25.8	33.3	33.8
Low-technology manufactures	45.8	49.9	65.4	72.2	72.1	86.1	83.4	85.4	101.9	105.0

Source: OECD, ITCS database.

Table SA 12: High-technology manufacturing exports (billions of USD)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
China	9.3	10.7	15.6	21.5	24.3	30.0	34.7	40.2	55.8	64.4
European Union	96.1	100.2	111.2	140.1	150.8	162.9	177.2	182.2	215.2	217.8
Hong Kong, China	26.2	30.6	37.0	46.2	47.9	51.6	57.2	53.0	67.6	67.5
Japan	100.7	108.3	121.4	137.9	124.3	127.2	115.2	125.8	151.9	118.4
Korea			26.7	36.9	30.0	38.4	37.1	48.7	63.5	48.4
Chinese Taipei	21.1	23.8	27.8	37.4		40.1	45.9	51.7		55.1
United States	120.7	121.4	133.7	146.8	163.5	192.7	227.7	243.1	273.8	251.0

Note: EU data exclude intra-EU trade.

Source: OECD, STAN and ITCS databases.

Table SA 13: Foreign Direct Investment: inflows (billions of USD)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Canada	7.6	2.9	4.7	4.7	8.2	9.3	9.6	11.5	22.8	24.4	66.6	27.5	21.4
China	3.5	4.4	11.2	27.5	33.8	35.8	40.2	44.2	43.8	38.8	38.4	44.2	49.3
France	15.6	15.2	17.8	16.4	15.6	23.7	22.0	23.2	31.0	46.5	43.3	52.6	48.2
Germany	3.0	4.7	-2.1	0.4	7.1	12.0	6.6	12.2	24.6	55.8	203.1	33.9	38.1
Hong Kong, China	3.3	1.0	3.9	6.9	7.8	6.2	10.5	11.4	14.8	24.6	61.9	23.8	13.7
Italy	6.3	2.5	3.2	3.8	2.2	4.8	3.5	5.0	4.3	6.9	13.4	14.9	14.6
Japan	1.8	1.3	2.8	0.2	0.9	0.0	0.2	3.2	3.2	12.7	8.3	6.2	9.3
Korea	0.8	1.2	0.7	0.6	0.8	1.8	2.3	2.8	5.4	9.3	9.3	3.5	2.0
Singapore	5.6	4.9	2.2	4.7	8.6	11.5	9.3	13.5	7.6	13.2	12.5	10.9	6.1
Chinese Taipei	1.3	1.3	0.9	0.9	1.4	1.6	1.9	2.2	0.2	2.9	4.9	4.1	1.4
United Kingdom	34.0	16.2	16.5	16.4	10.9	21.8	27.4	37.4	74.6	89.3	119.7	62.0	25.0
United States	48.5	23.2	19.8	51.4	46.1	57.8	86.5	105.6	179.0	289.5	307.7	130.8	30.1

Note: Data for 2001 are provisional and for 2002 estimated.

Sources: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

Table SA 14: Foreign Direct Investment: outflows (billions of USD)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Canada	5.2	5.8	3.6	5.7	9.3	11.5	13.1	23.1	34.3	15.6	47.5	35.5	27.9
China	0.8	0.9	4.0	4.4	2.0	2.0	2.1	2.6	2.6	1.8	0.9	6.9	2.5
France	36.2	25.1	30.4	19.7	24.4	15.8	30.4	35.6	48.6	126.9	177.5	93.0	62.6
Germany	24.2	22.9	18.6	17.2	18.9	39.1	50.8	41.8	88.8	109.6	56.9	42.1	24.6
Hong Kong, China	2.4	2.8	8.3	17.7	21.4	25.0	26.5	24.4	17.0	19.4	59.4	11.3	17.7
Italy	7.6	7.3	5.9	7.2	5.1	5.7	6.5	12.2	16.1	6.7	12.3	21.5	17.1
Japan	50.8	31.7	17.3	13.9	18.1	22.6	23.4	26.0	24.2	22.8	31.5	38.4	32.3
Korea	1.1	1.5	1.2	1.3	2.5	3.6	4.7	4.4	4.7	4.2	5.0	2.4	2.7
Singapore	2.0	0.5	1.3	2.2	4.6	3.0	6.2	9.0	0.4	5.4	6.1	9.5	4.1
Chinese Taipei	5.2	2.1	2.0	2.6	2.6	3.0	3.8	5.2	3.8	4.4	6.7	5.5	4.9
United Kingdom	19.4	16.4	19.8	27.3	34.7	45.3	34.8	62.7	121.5	202.3	255.2	68.1	39.7
United States	37.2	37.9	48.3	84.0	80.2	98.8	91.9	104.8	142.6	188.9	178.3	127.8	123.5

Note: Data for 2001 are provisional and for 2002 estimated.

Source: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

Table SA 15: Foreign Direct Investment: inward position (billions of USD)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Canada	113	117	109	107	110	123	133	136	143	175	205	209	221
China	25	29	40	68	102	137	178	222	267	308	348	395	448
France	85	97	128	135	163	191	200	196	246	245	260	289	401
Germany	74	78	75	71	86	102	103	189	250	289	440	453	452
Hong Kong, China	202	203	207	213	221	228	238	249	225	405	455	419	433
Italy	60	62	50	54	60	65	75	85	109	109	113	108	126
Japan	10	12	16	17	19	34	30	27	26	46	50	50	78
Korea	5	6	7	7	8	9	11	14	19	29	37	41	44
Singapore	30	36	36	42	55	66	75	76	87	101	113	116	124
Chinese Taipei	10	11	12	13	14	16	18	20	20	23	28	32	33
United Kingdom	204	208	173	179	190	200	229	253	337	385	439	532	639
United States	505	533	540	593	618	680	746	824	920	1102	1419	1514	1504

Note: Data for 2001 are provisional and for 2002 estimated.

Source: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

Table SA 16: Foreign Direct Investment: Outward position (billions of USD)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Canada	85	94	88	92	104	118	132	153	172	201	235	245	273
China	2	3	7	12	14	16	18	20	23	25	26	33	36
France	110	130	156	159	182	204	231	237	288	334	445	489	652
Germany	131	151	155	162	195	233	249	296	365	412	478	505	
Hong Kong, China	12	14	22	39	59	79	100	236	224	322	388	353	370
Italy	60	70	70	81	90	106	117	139	177	182	180	182	194
Japan	201	232	248	260	276	238	259	272	270	249	278	300	304
Korea	2	3	4	5	7	8	8	12	9	38	51	41	43
Singapore	8	9	11	13	26	35	40	45	46	56	53	67	71
Chinese Taipei	13	15	17	20	22	25	29	34	38	42	49	55	60
United Kingdom	229	232	222	246	277	305	330	361	488	686	898	899	1033
United States	732	828	799	1061	1115	1364	1608	1879	2280	2840	2694	2302	

Note: Data for 2001 are provisional and for 2002 estimated.

Source: OECD International direct investment database; IMF, Balance of Payments; and UNCTAD, FDI database.

Table SA 17: Number of researchers (thousands of full-time equivalents)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	471.4	471.9	489.2	552.0	522.0	548.0	588.7	485.5	531.1	695.1	742.7	810.5
European Union	746.5	761.0	769.8		817.0	833.3	849.3	884.9	925.7	965.7	1004.6	
Japan	491.1	511.4	526.5	541.0	552.0	617.4	625.4	652.8	658.9	647.6	675.9	
Korea					100.5	99.4	102.7	92.5	100.2	108.4	136.3	
Singapore				6.5	7.7	9.1	9.7	11.4	12.6	16.6	16.7	18.1
Chinese Taipei						45.8	47.6	53.5	54.8	55.5	59.7	
United States	981.7		1013.8		1036.0		1159.9		1261.2			

Note: There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1993 and for the EU in 1997.

Source: OECD, MSTI database.

Table SA 18: Researchers per thousand persons employed

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
China	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.7	0.7	1.0	1.0	1.1
European Union	4.7	4.8	5.0		5.2	5.3	5.4	5.5	5.6	5.8	5.9	
Japan	7.5	7.7	7.9	8.1	8.3	9.2	9.2	9.7	9.9	9.7	10.2	
Korea					4.9	4.8	4.8	4.7	4.9	5.1	6.3	
Singapore				4.0	4.5	5.2	5.3	6.1	6.7	7.9	8.2	9.0
Chinese Taipei						5.1	5.2	5.8	5.8	5.8	6.4	
United States	7.7		7.8		7.6		8.2		8.6			

Note: There is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1993 and for the EU in 1997.

Source: OECD, MSTI database.

Table SA 19: Gross Domestic Expenditure on R&D (billions of national currency)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
China	15.9	19.8	24.8	30.6	34.9	40.4	50.9	55.1	67.9	89.6	104.2	128.8	
European Union													
Japan	12.9	13.0	12.7	12.6	13.4	14.2	14.8	15.2	15.0	15.3	15.5		
Korea	4.2	5.0	6.2	7.9	9.4	10.9	12.2	11.3	11.9	13.8	16.1		
Singapore				1.2	1.4	1.8	2.1	2.5	2.7	3.0	3.2	3.4	
Chinese Taipei					125.0	138.0	156.3	176.5	190.5	197.6	205.0		
United States	161.4	165.7	166.2	169.6	184.1	197.7	212.7	226.8	244.0	265.2	274.8	277.1	284.6

Notes: there is a break in series for China between 1999 and 2000, see Box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional; trillions of national currency for Japan and Korea.

Source: OECD, MSTI database.

Table SA 20: Gross Domestic Expenditure on R&D (billions of current PPP $)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
China	12.5	14.9	16.7	17.5	18.4	20.3	25.4	27.9	36.0	48.5	57.1	72.1	
European Union	114.8	120.5	121.1	124.0	130.8	134.9	143.8	150.5	162.5	175.7	187.2		
Japan	66.9	69.1	69.1	69.9	78.7	85.5	90.8	90.5	92.8	98.3	103.8		
Korea	6.9	7.9	9.3	11.3	12.9	14.6	16.2	14.4	15.8	18.9	22.0		
Singapore				0.6	0.7	1.0	1.1	1.4	1.6	1.8	2.0	2.1	
Chinese Taipei					6.5	7.0	7.9	8.6	9.6	10.3	10.9		
United States	161.4	165.7	166.2	169.6	184.1	197.7	212.7	226.8	244.0	265.2	274.8	277.1	284.6

Notes: There is a break in series for China between 1999 and 2000, see box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional.

Source: OECD, MSTI database.

Table SA 21: Gross Domestic Expenditure on R&D as a percentage of GDP (%)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
China	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.7	0.8	1.0	1.1	1.3	
European Union	1.9	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.9	1.9	1.9		
Japan	2.8	2.7	2.6	2.6	2.7	2.8	2.8	2.9	3.0	3.0	3.1		
Korea	1.9	2.0	2.2	2.4	2.5	2.6	2.7	2.6	2.5	2.7	2.9		
Singapore				1.1	1.2	1.4	1.5	1.8	1.9	1.9	2.1	2.2	
Chinese Taipei					1.8	1.8	1.9	2.0	2.1	2.1	2.2		
United States	2.7	2.7	2.5	2.4	2.5	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.6

Notes: There is a break in series for China between 1999 and 2000, see box 5 for all methodological notes; in addition, there are breaks in series for the United States in 1997 and 1998, and the US data for 2002 and 2003 are provisional.

Source: OECD, MSTI database.

Table SA 22: Number of patent applications to the State Intellectual Property Office (SIPO) of the People's Republic of China (by residence of inventor and by priority year)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
China	5323	6507	8906	10793	10171	9877	11562	12412	12956	15943
European Union	1153	1275	2240	3908	4683	5306	6249	7512	8350	8376
Hong Kong, China	22	23	43	49	41	54	65	42	84	114
Japan	840	884	1638	3537	5078	5747	6496	7766	8060	9813
Korea	112	144	295	579	858	1350	1451	1808	1598	1707
Singapore	1	2	12	7	6	13	23	20	39	45
United States	1562	1587	2392	3773	4440	5010	6119	7199	8199	7334

Note: Data are provisional.

Source: OECD, Patent Database, July 2003.

Table SA 23: Number of patent applications to the European Patent Office (EPO) (by residence of inventor and by priority year)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
China	29	29	32	30	39	52	69	93	114	179	301
European Union	26923	26835	26938	27787	29410	30840	35729	40169	43951	47808	49353
Hong Kong, China	28	31	33	42	35	43	32	18	49	28	45
Japan	13000	11821	10939	11170	10846	12326	13775	14481	15271	17867	20676
Korea	118	168	199	291	363	455	450	620	880	1001	1218
Singapore	10	26	49	35	42	47	73	69	109	136	137
Chinese Taipei	111	129	133	115	107	97	125	142	173	227	243
United States	17443	17437	17782	18154	19188	21194	22393	24793	26899	28668	28140

Note: Data for 1999 and 2000 are provisional.

Source: OECD, Patent Database, November 2003.

Table SA 24: Number of patents granted by the US Patent and Trademark Office (USPTO) (by residence of inventor and by priority year)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
China	75	47	80	74	87	75	104	155	193	282
European Union	17990	18242	18683	19979	21461	22885	25445	27461	28091	27220
Hong Kong, China	69	72	67	84	113	121	148	142	184	234
Japan	25096	24091	24582	26282	26287	29512	32472	34775	34373	35443
Korea	767	1058	1166	1570	2062	3458	3705	3991	3804	3752
Singapore	18	59	76	73	105	102	175	202	262	395
Chinese Taipei	961	1129	1304	1638	2022	2291	3228	3770	4879	5530
United States	55727	57146	62202	66822	73794	76711	78460	88943	92699	92349

Note: Data for 1997 are provisional; data for 1998 and 1999 are estimated.

Source: OECD, Patent Database, November 2003.

Table SA 25: Number of "triadic" patent families (by residence of inventor and by priority year)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
China	12	12	16	17	18	19	22	39	47	68
European Union	9939	9112	9414	9771	10740	11448	12605	13083	13855	13402
Hong Kong, China	11	15	11	16	14	21	16	8	24	27
Japan	9931	8889	8150	8427	8175	9461	10602	11037	10960	11301
Korea	65	93	118	168	212	325	324	382	430	424
Singapore	4	20	18	17	22	25	32	25	50	75
Chinese Taipei	10	16	22	22	27	25	50	44	91	103
United States	11158	10217	10598	10503	11088	12064	12885	13916	14559	14504

Note: Data are by priority year; data for 1997 are provisional, data for 1998 and 1999 are estimated.

Source: OECD, Patent Database, November 2003.

ANNEX II: MAIN OECD DATABASES USED

Industrial structure and performance

STAN: The database for **Industrial Analysis** includes annual measures of output, labour input, investment and international trade which allow users to construct a wide range of indicators focused on areas such as productivity growth, competitiveness and general structural change. The industry list provides sufficient details to enable users to highlight high-technology sectors and is compatible with those used in related OECD databases. STAN is primarily based on member countries' annual National Accounts by activity tables and uses data from other sources, such as national industrial surveys/censuses, to estimate any missing detail. Since many of the data points in STAN are estimated, they do not represent the official member country submissions.

The latest version of STAN is based on the International Standard Industrial Classification (ISIC) Rev. 3 and has been expanded to cover all activities (including services) and a wider range of variables - it has effectively been merged with the OECD' s International Sectoral Database (ISDB) which is no longer updated. Further details on STAN are available on the Internet at: www.oecd.org/sti/stan.

Publication: STAN is available on line on SourceOECD (www.sourceoecd.org). It is updated on a "rolling" basis (*i.e.* new tables are posted as soon as they are ready) rather than published as an annual "snapshot", in order to improve timeliness.

Globalisation and international trade

AFA: The **Activities of Foreign Affiliates** database presents detailed data on the performance of foreign affiliates in the manufacturing industry of OECD countries (inward and outward investment). The data indicate the increasing importance of foreign affiliates in the economies of host countries, particularly in production, employment, value added, research and development, exports, wages and salaries. AFA contains 18 variables broken down by country of origin and by industrial sector (based on ISIC Rev. 3) for 18 OECD countries.

Publication: OECD, *Measuring Globalisation: The Role of Multinationals in OECD Economies*, 2001 Edition. Vol. I: Manufacturing. Biennial.

FATS: This database gives detailed data on the **activities of foreign affiliates** in the **services** sector of OECD countries (inward and outward investment). The data indicate the increasing importance of foreign affiliates in the economies of host countries and of affiliates of national firms implanted abroad. FATS contains five variables (production, employment, value added, imports and exports) broken down by country of origin (inward investments) or implantation (outward investments) and by industrial sector (based on ISIC Rev. 3) for 19 OECD countries.

Publication: OECD, *Measuring Globalisation: The Role of Multinationals in OECD Economies*, 2001 Edition. Vol. II: Services. Biennial.

Bilateral Trade (BTD): This database for industrial analysis includes detailed trade flows by manufacturing industry between a set of OECD *declaring* countries and a selection of *partner* countries and geographical regions. Data are presented in thousands of USD at current prices, and cover the period 1988-2000. The data have been derived from the OECD database *International Trade by Commodities Statistics* (ITCS - formerly *Foreign Trade Statistics* or FTS). Imports and exports are grouped according to the country of origin and the country of destination of the goods. The data have been converted from product classification schemes to an activity classification scheme based on ISIC Rev.3, that matches the classification currently used for the OECD' s STAN, Input-Output tables and ANBERD databases.

Publication: OECD (2003), *Bilateral Trade Database, 2002*. Only available on diskette.

Science and technology

R&D: The **R&D** database contains the full results of the OECD surveys on **R&D expenditure and personnel** from the 1960s.

Publication: OECD (2003), *Basic Science and Technology Statistics: 2002 Edition*. Annual on CD-ROM (a printed edition is also available every two years).

MSTI: The **Main Science and Technology Indicators** database provides a selection of the most frequently used annual data on the scientific and technological performance of OECD member countries and seven non-member economies (China, Israel, Romania, Russian Federation, Singapore, Slovenia, Chinese Taipei). The indicators, expressed in the form of ratios, percentages, growth rates, cover resources devoted to R&D, patent families, technology balance of payments and international trade in highly R&D-intensive industries.

Publication: OECD (2003), *Main Science and Technology Indicators 2003/2*. Biannual. Also available on CD-ROM.

ANBERD: The **Analytical Business Enterprise Research and Development** database is an estimated database constructed with a view to creating a consistent data set that overcomes the problems of international comparability and time discontinuity associated with the official business enterprise R&D data provided to the OECD by its member countries. ANBERD contains R&D expenditures for the period 1987-2000, by industry (ISIC Rev. 3), for 19 OECD countries.

Publication: OECD (2002), *Research and Development Expenditure in Industry, 1987-2000*. Annual. Also available on diskette.

Patent database: This database contains patents filed at the largest national patent offices **-** European Patent Office (EPO); US Patent and Trademark Office (USPTO); Japanese Patent Office (JPO) – and other national or regional offices. Each patent is referenced by: patent numbers and dates (publication, application and priority); names and countries of residence of the applicants and of the inventors; and technological categories, using the national patent classification as well as the International Patent Classification (IPC). The compiled indicators mainly refer to single patent counts in a selected patent office, as well as counts of “triadic” patent families (patents filed at the EPO, the USPTO and the JPO to protect a single invention).

The series are published on a regular basis in OECD, *Main Science and Technology Indicators.*

Other OECD databases

ANA: Annual National Accounts (Statistics Directorate).

Education database (Directorate for Education, Employment, Labour and Social Affairs).

ITCS: International Trade in Commodities Statistics (Statistics Directorate).

International Direct Investment (Directorate for Financial, Fiscal and Enterprise Affairs).

SSIS: Structural Statistics for Industry and Services (Statistics Directorate).

Services: Value Added and Employment (Statistics Directorate).

Further details on OECD statistics are available on the Internet at: http://www.oecd.org/statistics/