Deutsche Bank Research

International division of labour in R&D

Research follows production

February 3, 2011

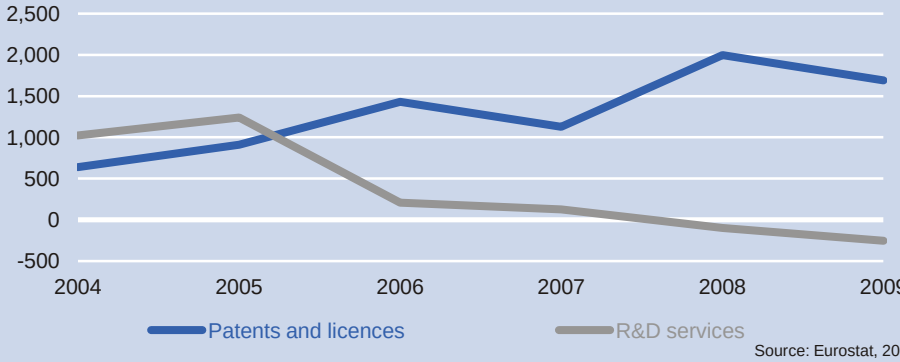
The leading technology companies not only manufacture worldwide, they also carry out research and development worldwide. Over 90% of them now operate R&D facilities outside their home country. Cross-border relations are also increasing: German exports and imports of R&D services have risen by 9% p.a. in recent years.

Emerging markets are becoming popular R&D locations. Their primary purpose is to open up markets with products that are tailored to local preferences and requirements. What is new, however, is that a dynamic technology transfer is occurring from emerging markets back to industrial nations: for the first time China is now a net exporter of R&D services to the EU – also abetted by the presence of foreign companies' R&D facilities in China.

Capacities and a policy mission are the driving forces. Many emerging markets have made stunning advances in research, education and technology. Over the last 10 years, for example, their R&D expenditure has more than doubled – to 1.2% of GDP. International companies want to tap into these capacities. Furthermore, in China in particular there is a clear policy mission of promoting domestic innovations, for example by giving awards for patents.

The innovation process is becoming more efficient – management is becoming more important. The division of labour and specialisation are bringing down costs, fostering competition and leading to modularised work processes. R&D activities are no exception. Managing complex innovation networks and the commercial application of new ideas – wherever they emerge – are becoming more important for companies. Emerging markets are also becoming more competitive in high-tech goods and services – but this also means they require more high-quality intermediate products and expertise.

China is a net exporter of R&D services to the EU
EU external trade with China and Hong Kong, net (EUR m)



Source: Eurostat, 2010

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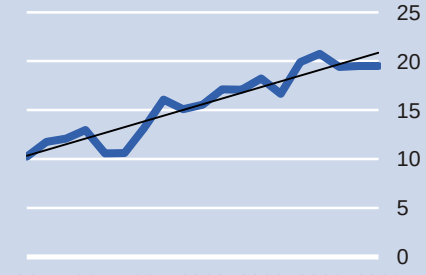
In modern innovation-oriented companies research and development (R&D) is naturally of outstanding importance. R&D activities are a source of new and improved products and processes and are therefore pivotal to the competitive position. For many companies R&D is therefore conducted subject to the conflicting demands of protection and collaboration. On the one hand, conducting R&D in a very open manner jeopardises a firm's competitive edge as competitors could copy innovations. On the other hand, the division of labour and specialisation are becoming increasingly important factors in efficiently structuring the innovation process. Collaborating with other companies, universities or other research institutions is often essential in order to keep up with the ever shorter technology and innovation cycles.

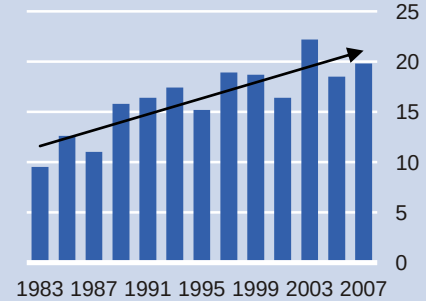
Research contracted out rather than in-house
Share of external R&D spending by firms in Germany (%)



Sources: DB Research, Stifterverband, 2010 **1**

In recent years there has been much greater readiness to co-operate in the innovation process. Companies in Germany have become much more open, for example. The share of the overall R&D budget spent on external research assignments has risen from 10% to 20% over the last 20 years (see chart 1) – with large sector-specific differences. The external R&D spending in 2009 came to roughly EUR 11 bn. The majority (59%) of external R&D contracts goes to other companies (incl. affiliates), while 11% go to universities and professors, 9% to other state research institutions and 20% to foreign facilities. The contribution of foreign partners has trended up even faster than the total volume of external R&D contracts over the last 25 years. As a consequence the foreign share rose from less than 10% (in 1983) to nearly 20% (in 2007) of all external R&D expenditure (see chart 2). However, most of the foreign-based contractors are affiliates of the sourcing firm. These figures, nevertheless, graphically demonstrate the internationalisation of the R&D segment.

Foreign share growing
Share of foreign contractors in external R&D spending by German companies (%)



Source: Stifterverband, 2010 **2**

In the light of these trends this report takes a closer look at the significance of global R&D locations for a modern innovation process. In so doing we also look beyond the traditional R&D centres in Europe, Japan and the US.

The report starts with an overview of the global research activities of major technology groups and the increasing division of labour in the R&D segment. While most collaboration currently occurs between industrial nations, we shall subsequently demonstrate that aspiring emerging markets like China and India are developing major appeal. R&D facilities in emerging markets have been traditionally restricted to the role of helping to open up new markets (e.g. for adapting products to local preferences and requirements). The report, however, also provides the first indications of a fast-growing transfer of knowledge and innovations from emerging markets back to industrial nations. These trends are attributed to the dramatically increased capacities for research, education and technology. In China's case, furthermore, the government is pursuing the clear policy mission of catching up with the leading technology nations. As a consequence the innovation process is becoming more collaborative and more efficient. Management and the commercial application of new ideas are becoming more important than simply generating knowledge.

International companies have global research operations

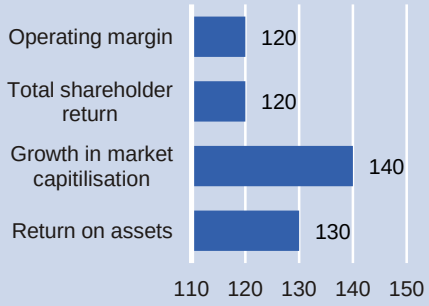
Many international companies operate research centres outside their home market – a development that is not new: IBM, for example, opened its first overseas research centre in the 1950s in Switzerland. In the meantime, however, foreign activities have become the rule rather than the exception for the big technology companies. About 55% of innovation spending by the 1,000 companies that conduct the most research worldwide is made at foreign locations. Just 9% of the big technology companies confine their innovation activity exclusively to the domestic market.[1]

Jaruzelski and Dehoff (2008) show that technology firms which structure their R&D activities globally can post better financial results on average. Companies with international research operations achieve higher margins, higher profits and higher market capitalisation (see chart 3). Local R&D capacities help to adapt products to the respective markets and to correctly gauge customer requirements. Furthermore, above-average success is enjoyed by companies that concentrate their foreign R&D at a few locations and focus greater attention on low-wage countries like China and India.[2]

Such comparisons certainly give no grounds for concluding that an international configuration for R&D spending automatically guarantees higher profits. Companies that are successful in the first place could also expand more boldly abroad. Global research activities moreover reflect the generally increased international presence of many firms. Often international research centres are acquired in the process of company takeovers (and are sold off again in the case of divestures or spin-offs). R&D activities thus sometimes tend to be allocated according to the changes in ownership rather than to the actual research collaboration.

Apparently contradictory trends can emerge as a result of acquisitions and divestures. Since 2001, for example, R&D spending by subsidiaries of German companies abroad has declined by 20% (see chart 4), whereas total R&D expenditure has risen by 22%. This could create the impression that German companies had curtailed their foreign R&D activities.[3] However, it must be noted that in this case, too, the allocation is primarily a reflection of the respective ownership arrangements. The decline in foreign R&D expenditure between 2005 and 2007 for example was heavily concentrated on the automaking sector, where foreign R&D spending nosedived by EUR 1.8 bn. However, the majority of this total (some EUR 1.6 bn) was due to the disposal by Daimler of its US subsidiary Chrysler.[4] Such transactions mask the actual changes in research collaboration.

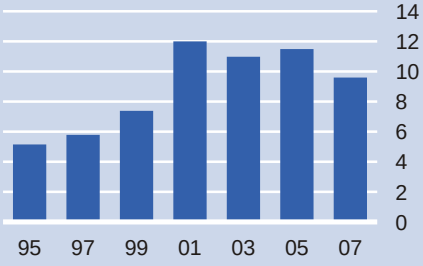
Global and successful
Companies that invest more than 60% of their R&D spending abroad
(index, 100 = firms with < 60%



Basis: detail analysis of the 184 biggest technology companies by R&D spending, average 2005-2007

Source: Jaruzelski & Dehoff, 2008 **3**

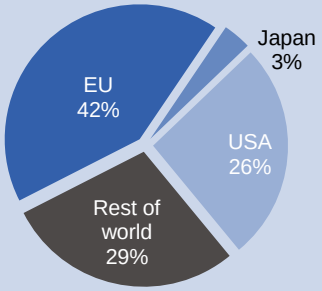
Less R&D by German subsidiaries abroad
R&D spending by German subsidiaries abroad (EUR bn)



Source: Stifterverband, 2010 **4**

[1] Based on a detailed analysis of the 184 biggest technology companies (measured by R&D expenditure). See Jaruzelski, Barry and Kevin Dehoff (2008). Beyond Borders: The Global Innovation 1000. strategy+business issue 53, Winter 2008.
[2] See Jaruzelski, Barry and Kevin Dehoff (2008), p. 7.
[3] See Kladroba, Andreas, Christoph Grenzmann and Bernd Kreuels (2010). FuE-Datenreport 2010: Analyse und Vergleiche. Stifterverband für die Deutsche Wissenschaft, p. 43.
[4] See Belitz, Heike (2010). Deutsche Firmen forschen weniger im Ausland. Wochenbericht des DIW Berlin No. 20/2010, p. 3.

Whose idea?
Patent filings in Germany with foreign partners, by region



2004-2006

Source: OECD, 2010 **5**

R&D: Division of labour on the rise

In the innovation process there is a noticeable trend towards an international division of labour. The main issue is how joint research projects are shared among internationally linked R&D units.

One indication of the shared research workload is for example the patents that are filed jointly with foreign partners. Foreign partners are involved in around 16% of all patents filed by German inventors. Most of these partners come from other EU states, while 26% come from the US and 3% from Japan (see chart 5).

Trade in research and patents

An even deeper insight into the tie-ups within the innovation process is given by the trade flows in the international service sector. Trade flows may be more suitable for illustrating the actual exchanges of R&D since this data is collected regardless of the form of ownership. The balance of payments also records transactions within affiliated companies, such as the research contribution made by a foreign subsidiary of a German carmaker.[5] Research & development services and the payments for patents and licences are particularly relevant.

Patents and licences that are traded internationally typically relate to production-ready technologies. Whereas other patents often have more of a defensive character (to stymie competitors) and seldom lead to new products or processes, traded patents are very likely to be earmarked for exploitation.

In 2009 German companies, institutions and consumers paid EUR 7.7 bn for foreign patents and licences and generated revenues of EUR 6.9 bn.[6] The deficit has narrowed compared to previous years. In R&D services there is a significant export surplus: in Germany services worth EUR 8.1 bn are rendered for clients outside Germany and services worth more than EUR 6.3 bn are imported.

Think global
German trade flows, by partner, 2008 (EUR m)

	Patents and licences	
	Exports	**Imports**
USA	1,323	3,937
EU	2,484	2,736
Asia	1,041	305
Rest of world	1,180	1,179
	Research and development	
	Exports	**Imports**
USA	2,994	1,272
EU	2,856	2,912
Asia	1,022	474
Rest of world	1,365	622

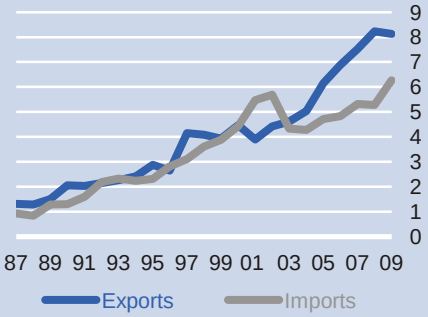
Sources: DB Research, Eurostat 2010 **6**

Germany conducts a particularly intensive exchange of research and development with other industrial nations, mainly with its EU partners and the US. Specifically in relation to the US there are striking differences between patents and R&D services: demand in Germany for US patents and licences (for example for software, licensed products, films and music) is considerably higher than the demand for German patents in the US: the difference came to more than EUR 2.6 bn in 2008.[7] The US occupies top spot for producing patents and licences, which emphasises its role as a leading technology nation. The situation is different for R&D services: Germany has a surplus with the US of EUR 1.7 bn. This shows that the US also receives help from foreign partners to gain its technological edge.

The trade volumes of patents & licences and R&D services display a clear uptrend: exports of both items have risen by an annual average of about 9% for the last 20 years; imports of patents & licences have climbed 6% p.a. and R&D imports have risen 9% p.a. (see charts 7 and 8). This is a clear indication that there is growing

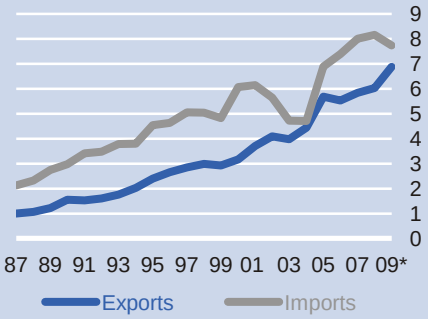
[5] However, the proviso is that particularly those services rendered within affiliated companies are not always logged correctly or that companies structure their service flows so that they are tax optimised.
[6] German revenues from patents and licences in fact rose to a total of EUR 9.9 bn in 2009; expenditure climbed to EUR 10.2 bn. This large increase is primarily due to the trade in emissions permits. To prevent distortions we have not factored in the change in this sub-item for 2009.
[7] Figures for partner countries for 2009 are not yet available.

Research globalised
German exports and imports of R&D services (EUR bn)



Source: Bundesbank, 2010 **7**

Gap closing
German exports and imports of patents and licences (EUR bn)



*Excluding change in emissions right

Source: Bundesbank, 2010 **8**

Siemens: R&D facilities in BRIC countries

Location	No. of researchers	Areas include
Bejing	160	Environment, energy
Shanghai	55	Radio technology
Bangalore	90	Software, renewable energies
Moscow	21	Nanotechnology
St. Peters-burg	26	Risk analysis, remote maintenance

Source: Siemens, 2010

global integration in the research and development field and in cross-border knowledge transfer.

In the crisis year 2009 German R&D performed robustly. Exports of patents and licences increased further; imports fell slightly. Exports of R&D services declined a little in 2009; imports rose somewhat. German expertise is thus in demand worldwide.

R&D in emerging markets: Opening up markets and first signs of division of labour

The motives behind establishing international research capacities are basically similar to those for other stages of the production process: comparative advantages come from cost, capacity, proximity to important markets etc. R&D in particular is an area where industrial countries typically enjoy significant advantages over emerging markets as they have, for example, access to a larger pool of skilled personnel and high-tech companies, have established innovation networks, strong protection of intellectual property rights and large markets for innovative products. They are therefore the preferred target for “knowledge-augmenting” strategies, with which companies tap into the research capacities of new locations in order to gain fresh stimuli and innovations for their own, central R&D processes.

Where the purpose of R&D facilities is, by contrast, not to develop new products, but to adapt a selected range of products to local requirements, preferences and purchasing power, the jargon used to describe this is “knowledge-exploiting” strategies. With them the technological expertise that companies have accumulated in their home markets is used to provide local markets with adapted products. This is the strategy that is often ascribed to R&D facilities in emerging markets in the literature. One example, for instance, is adapting motor vehicles to the mostly poorer condition of the roads in the destination country.

China and India are aspiring research locations for international technology groups. In 2007 they invested nearly USD 40 bn in R&D facilities. Companies from a variety of sectors such as GM (automaking), Pfizer (pharma), Microsoft (software) or Siemens (technology) operate R&D centres in China, India and often at other facilities in emerging markets.[8] The development in outsourcing and offshoring has provided impressive evidence that facilities in emerging markets also possess the expertise to perform complex tasks. Software development, bookkeeping or market analyses are often only the first stage in the value chain. Service providers in India, for instance, managed to grow their offshoring revenues from R&D engineering services from USD 2-3 bn in 2006 to nearly USD 8 bn in 2009.[9]

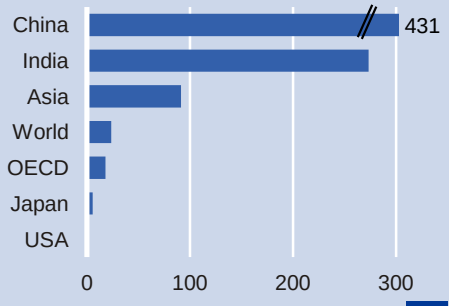
Siemens now employs some 350 scientists and experts at facilities in BRIC countries. This represents nearly 19% of the company’s research team (see table). According to the company, the facilities in China and India focus on innovations and technologies that are geared specifically to requirements in emerging markets. These facilities are thus tending to pursue the above-mentioned “knowledge-exploiting” strategies.

Taking a broader view, Schmiele and Mangelsdorf (2009) show that German companies primarily set up R&D facilities in Asia (excluding

[8] See Hira, Ron (2008). The offshoring of innovation. EPI Briefing Paper #226.
[9] NASSCOM and Booz & Co. (2010). ER&D: Accelerating Innovation with Indian Engineering. New Delhi.

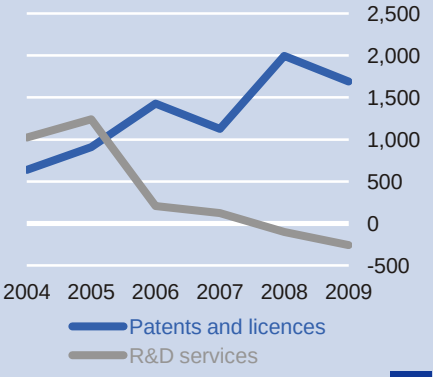
Japan) when they also sell innovative products in Asia. If their markets for innovative products are, by contrast, located in other industrial nations then they are less likely to operate Asian research facilities. This also supports the opening-up of markets (*"knowledge-exploiting" strategies*) as the dominant motivation for operating R&D capacities in emerging markets.[10]

Expertise for Germany
German imports of R&D services, change 2004-2008 (%)



Sources: DB Research, Eurostat, 2010 **9**

Net exporter of R&D
EU external trade with China & Hong Kong, net (EUR m)



Source: Eurostat, 2010 **10**

Initial drivers towards division of labour

Nevertheless there are first signs of a fast-growing role for "knowledge-augmenting" strategies in emerging markets, with some R&D facilities now involved in developing technologies that are planned specifically for use in industrial nations. In addition, some innovations that were originally intended for emerging markets also prove to be useful in industrial countries.

In 2008 German companies bought R&D services worth EUR 92 m from China and EUR 112 m from India. These flows reflect a knowledge transfer from China and India respectively to Germany that complements the research activities at the domestic facility. They currently represent just a fraction of the services that are procured from other industrial nations, but they are growing much faster. While R&D services imported into Germany rose by a total of 23% between 2004 and 2008, exports of research services from India increased by more than 270% and from China by more than 400% (see chart 9).

At the European level the growth is just as dynamic: imports of R&D services from India into the EU have risen by 2 ½ times; and from China by 3 times: the result is that the once robust external trade surplus has been transformed into a small deficit, i.e. China has become a net exporter of R&D services to the EU. Germany still has a small surplus of EUR 28 m with China. The situation is different with patents and licences. In this area the EU has managed to steadily boost its surplus in recent years to EUR 1.7 bn at last count (see chart 10). Taking both trends together, the picture that emerges is that China is on the one hand increasingly establishing itself as a producer of research, but that on the other hand it is calling on expertise from Europe. In the case of India this pattern is even more pronounced: the EU deficit on R&D services now comes to EUR 760 m; the surplus on patents and licences, by contrast, is just EUR 165 m. This reflects, among other things, the above-mentioned status of India as an offshoring location for many IT and development projects.[11]

Capacities and costs

The reasons for the elan with which the emerging markets are becoming integrated in global innovation processes are a combination of general trends towards division of labour and specialisation, cost advantages and rapidly growing capacities in emerging markets.

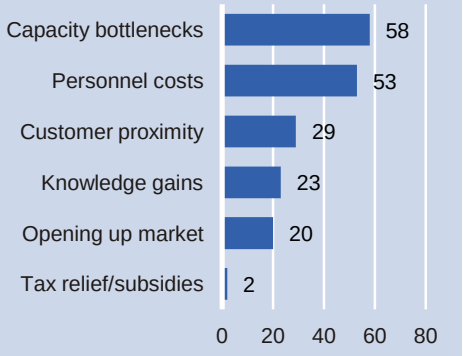
R&D facilities are often located next to already established production plants. This is logistically simpler and the proximity to production is helpful especially for development-oriented R&D activities in the manufacturing sector. As such, the heavily

[10] Schmiele, Anja and Axel Mangelsdorf (2009). Drivers of International R&D to Asian Economies – A Perspective from German Companies. Paper prepared for the 6th Asiatics International Conference.

[11] Interestingly, the EU trade pattern with these emerging markets – deficit on R&D services, surplus on patents – is strikingly similar to that, for example, of the US with Germany.

Capacities and costs

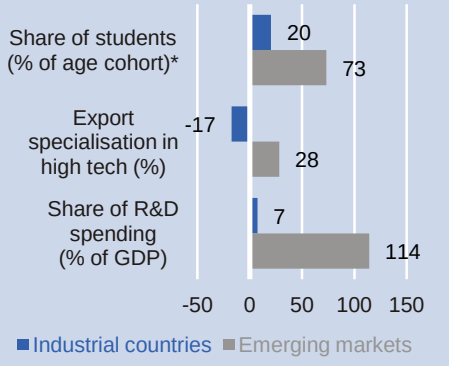
Motives for R&D relocation (% of researching companies in the manufacturing industry, 2006)



Source: Kinkel und Maloca, 2008 **11**

R&D capacities growing

Change 1997-2007 (%)

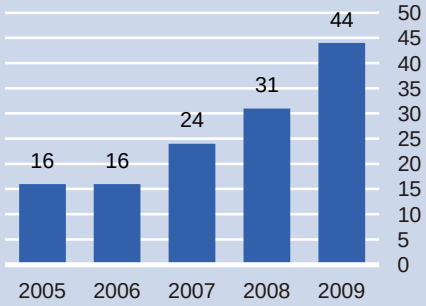


*1999-2007

Sources: DB Research, World Bank, 2010 **12**

On the rise

Number of top technology companies from emerging markets



Basis: top 1,000 companies with the highest R&D spending worldwide

Sources: DB Research, IPTS, 2010 **13**

international structuring of R&D is also a consequence of the global division of labour, the improved communication facilities and the accumulated experience of management in enabling collaboration between internationally linked units.

The significance of personnel costs is certainly a contentious issue. Studies show that for R&D facilities outside industrial nations low personnel costs are a major factor[12], and in surveys companies also cite the level of personnel costs as an important reason for relocating production (see chart 11). R&D personnel in emerging markets do indeed earn far less on average than in rich countries. In China for example they receive about EUR 6,000 per year, whereas in western Europe personnel costs are about 10 times higher (with big regional differences). International companies do not, however, pay average wages in emerging markets, but search for the brightest and most talented minds. The salaries for these highest-calibre specialists are already closer to those in industrial nations and the differences are steadily disappearing.[13] For practitioners labour costs are therefore often secondary. In addition, many companies complain about the high turnover among skilled staff, especially after they have invested in training these employees.

From workbench to think tank

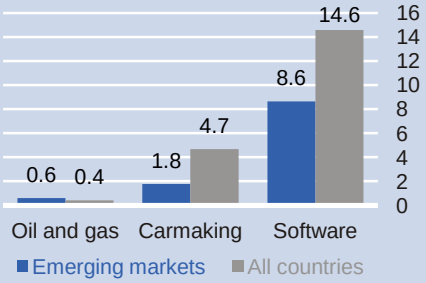
Emerging markets are becoming highly attractive thanks to substantial progress made over the last ten years in research, education and the use of modern technologies. For instance, the group of countries with low to middle incomes (emerging markets) managed to raise their share of students in the corresponding age cohort from 11% to 18% – an increase of 73%. In countries with high incomes (industrial countries) the share rose by only 20%. The situation is similar for other R&D indicators (see chart 12). These figures actually underestimate the actual pace of growth because the population, economy and exports are growing faster in emerging markets than in industrial countries. Boosting the share of students, for example, is thus all the more impressive given the faster growing basis.[14]

Different levels certainly need to be noted: high growth rates are also a consequence of the huge amount of ground to be made up in emerging markets. Industrial nations, for example, spend roughly 2.5% of GDP on R&D, whereas in emerging markets the figure is just 1.2% (with a large proportion of this often coming from government sources). Furthermore, China is a major factor in this dynamism. Nevertheless, the comparison shows that many emerging markets are giving up their extended workbench roles and are also breaking into higher-quality segments with R&D.

On the company side, too, significant progress is being made. Of the 1,000 biggest technology companies (in terms of R&D spending) 44 now come from emerging markets. In 2005 there were just 16 (see chart 13). Among the big technology groups in emerging markets are many commodity producers such as PetroChina, the Brazilian mining company Vale and Russia's Gazprom. There are, however, other examples from the telecommunications sector (e.g. Huawei Technologies or ZTE from China), the IT and software

[12] See for example Cincera, Michel, Claudio Cozza and Alexander Tübke (2010). Drivers and policies for increasing and internationalising R&D activities of EU MNEs. IPTS Working Paper 2/2010, p. 19f.
[13] See Jaruzelski, Barry and Kevin Dehoff (2008). p. 5.
[14] The quality of training, patents or other areas of R&D is definitely a contentious issue and does not always reach western levels.

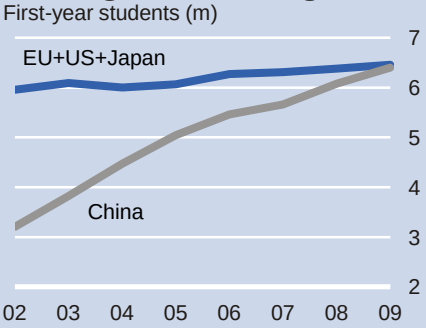
Research provides the edge
R&D spending (as % of turnover)



Basis: top 1,000 companies with the highest R&D spending worldwide

Sources: DB Research, IPTS, 2010 **14**

The edge is vanishing
First-year students (m)



Values for 2008-2009 estimated for EU+US+JP

Sources: DB Research, Eurostat, National Statistics of China, 2010 **15**

sector (e.g. Prithvi Information Solutions and Polaris Software Lab from India), aircraft making (Embraer from Brazil) and other sectors.[15] Overall, companies from China and Hong Kong are the biggest group (21), followed by Indian (12) und Brazilian (6) companies. These companies are, on the one hand, an indicator of the technological capabilities of these countries and, on the other, potential partners for joint research projects.

Research intensity in emerging markets is, however, mostly lower than in industrial countries. The 1,000 biggest technology groups invest a total of 3.6% of their revenues in R&D. Among companies from emerging markets the figure is just 1.2%. This impression is also backed up by differentiating according to sector (see chart 14)[16]: only the oil and gas producers from emerging markets invest a larger share of their turnover in R&D than the average. Rising commodity prices are probably the primary incentive for R&D in these sectors since the objective is to tap new or hitherto uneconomic deposits.

Politics is a factor – take China, for example

China is a major player on account of its size and dynamism. As in other aspiring emerging markets, China has also seen its R&D intensity increase significantly as per-capita income has risen.[17] In 2007 domestic R&D spending amounted to 1.5% of GDP – a higher share than in Russia, Brazil and India, but lower than the global average. The corporate sector now accounts for some 75% of total R&D spending. Chinese firms are expanding globally (e.g. Huawei) or acquiring foreign R&D capacities via takeovers (e.g. Lenovo or Geely).

China's output of university graduates and researchers is also rising fast. This year more people will start tertiary education in China than in the EU, the US and Japan put together (see chart 15). However, not all these graduates will be unreservedly suitable candidates for employment in international companies. Training is often criticised for lacking practical relevance, which makes additional, introductory on-the-job instruction necessary.

In the meantime numerous cooperation agreements exist at government level, and knowledge transfer has increased strongly. The number of Chinese scientists involved in international collaboration projects in one form or another had risen from nearly 50,000 in 2001 to almost 70,000 in 2008. Over the same period the number of foreign scientists travelling to China or collaborating with Chinese scientists tripled – to nearly 100,000 in 2008. Besides this intergovernmental cooperation and academic exchange it is primarily at multinational companies that the trend towards establishing local R&D capacities rapidly accelerated in the years following China's accession to the WTO. The number of R&D facilities belonging to international companies had risen from an

[15] The data come from the 2010 R&D Industrial Scoreboard of the Institute for Prospective Technological Studies (IPTS) of the Joint Research Centres of the European Union. The Scoreboard contains an overview of the 1,000 companies with the highest expenditure on R&D. The top spot in 2009 was taken by the Japanese automaker Toyota (EUR 6.8 bn.); Deutsche Bank ranks in 472nd place (EUR 130 m).

[16] Only sectors with more than three companies in emerging markets are taken into account.

[17] Brahmbhatt, Milan and Albert Hu (2010). Ideas and Innovation in East Asia. In: The World Bank Research Observer, Vol. 25, No. 2 August 2010. pp.177-207.

estimated 50 in 2000 to about 1,000 in 2007.[18] These companies include, for example, Intel, Microsoft, Bayer, GlaxoSmithKline, Volkswagen and Toyota.

These developments are bearing fruit: of the major economies China is the only country to increase its patent filings for inventions over the last 5 years. In 2009 the Chinese broke the 300,000 barrier for the first time and were thus twice as high as in the EU and South Korea.[19] In a few years China could become the country that files the highest number of patents in the world (see chart 16).

Centrally planned innovation – a contradiction in terms?

The rise of China as a research location is not only the outcome of a natural process, it is also a clear policy mission: China aims to become a leading scientific power by 2050. In many official documents the importance of domestic innovations (*zizhu chuanxin*) is emphasised and backed up by a raft of measures. These include, for example:

— The Ministry of Economics and Technology programme (2006-2020), whose objectives include boosting R&D spending to 2.5% of GDP by 2020,[20]

— Targeted public funding for technology clusters, including areas such as energy, IT, biotechnology, and aerospace,[21]

— Incentives and bonuses for patent filings by companies and universities.[22]

According to current draft proposals foreign companies will only gain access to the public procurement market, which is worth well over EUR 100 bn, if a commensurate R&D contribution is made locally.[23] Clearly, real innovations seldom follow on from precise centrally planned targets. Many political measures first increase the volume of research efforts, but not necessarily the output of innovations. For example, researchers in China are publishing more and more scientific papers, but the frequency with which they are quoted is below average – which is an indication that they are lacking in usefulness. The situation is similar with patents: foreign firms that file a patent for inventions are also granted this patent in nearly 60% of cases; for Chinese applicants the share is only 30%.

Collaboration requires trust

The stumbling block in China – as in many other emerging markets – remains the protection of intellectual property (see chart 17). International division of labour with regard to innovative processes and R&D is, however, virtually impossible if due respect is not given to the services provided by partners. There is nonetheless no place for unrealistic expectations.

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[18] Bruche, Gert (2009). The Emergence of China and India as New Competitors in MNCs' Innovation Networks. In: Competition & Change, Vol. 13, No. September 3, 2009, p. 267-288. p. 275.

[19] WIPO (2010). World Intellectual Property Indicators 2010. p. 22f.

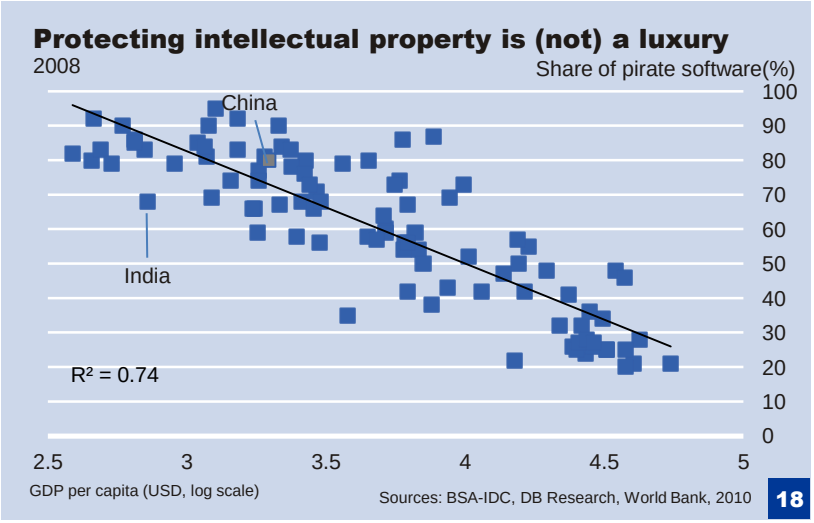
[20] Abele, Corinne (2010). Innovation mit chinesischem Antlitz. GTAI, March 18, 2010; World Bank (2009). Promoting enterprise-led innovation in China.

[21] For more details see UNESCO (2010). UNESCO Science Report 2010: The Current Status of Science around the World. pp. 378-399.

[22] See The Economist (2010): Innovation in China: Patents yes; ideas, maybe. October 14, 2010.

[23] This provision is earning criticism from companies in the US and Europe and is still the subject of negotiations. China has not yet acceded to the WTO's Agreement on Government Procurement (GPA), but is however involved in the admission process. See, for example, European Union Chamber of Commerce in China. European Business in China. Position Paper 2010/2011, p. 112.

The issue of software piracy provides a good example. Software piracy is a typical sign of insufficient protection of intellectual property and is widespread in emerging markets. In fact, the stage of economic development explains nearly 75% of the variation in software piracy (see chart 18).



It therefore comes as little surprise that more pirate copies are made of software in China than in Germany, for example. Compared with similarly developed economies, however, China's level of software piracy is worse: based on China's GDP per capita its expected pirated software share would be 71%. In fact, the figure is 79%. In Hong Kong the discrepancy is even greater at 48% (actual) compared with 33% (expected). By contrast, in India and Brazil the actual figures are lower than expected; in Russia both figures are virtually identical. The very success of the Indian IT industry is also closely linked with the relatively good protection for software: the share of pirated software in India is some 20 percentage points lower than the expected value.

There is, however, no disputing the fact that progress is being made in China. Whereas, for example, the share of pirated software has risen worldwide, its share in China has fallen from 86% to 79% in recent years. This progress has, however, not always been able to keep pace with the country's general economic dynamism.

The example of China impressively demonstrates the speed with which emerging markets are expanding their R&D expertise. In addition to the natural catching-up process, however, a clear, political agenda is also becoming apparent, one that banks on domestic innovations and requires technology transfer via foreign partners. International technology groups are using China as a research location not only to gain access to an attractive market, tap domestic capacity and cut costs, but also to curry favour with China's political elite. In so doing they weigh up the advantages of collaboration against the risks to their intellectual property. Smaller emerging markets that are less appealing and possess less market clout have to offer more from the outset.

Conclusions

The trend towards international division of labour and specialisation is not bypassing the R&D departments of firms. Although these are of course particularly sensitive areas, companies have also become much more open in this respect. A majority of the research partners of international technology groups are located in other industrial nations, but emerging markets – specifically China and India – are becoming increasingly interesting.

Personnel costs are of secondary importance here – the pay advantages for high-flyers in emerging markets compared with industrial countries are steadily disappearing. Instead, the proximity to other local production facilities, the dynamic progress in education and research as well as an ambitious industrial policy are key factors. A new development is that technology transfer is also taking place from emerging markets back into industrial nations: China and India are net exporters of R&D to the EU. The levels are still low, but the dynamism is impressive.

With the technological capacities the concern about larger global imbalances in external trade could grow, after all the emerging markets are expanding their range of exports. With it, however, the need will also grow for advanced knowledge, higher-quality intermediate products and capital goods. The export opportunities for technology groups in industrial nations will thus also increase. The net effect is by no means clear.

What are the consequences for the innovation process? The division of labour and specialisation are bringing down costs, fostering competition and leading to more modularised work processes. This is making research more efficient. It is, however, losing some exclusivity – in precisely those cases where it is not cutting-edge research but routine tasks within R&D.

The management of innovation processes and the ability to coordinate global networks are becoming vital. With the expansion in technological capacities – around the world – generating knowledge as a means of gaining comparative advantage is becoming less important. The identification of potentially money-making ideas – wherever they occur – and their commercial application are becoming much more relevant, by contrast.

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