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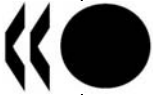
Improving the Capacity
to Innovate in Germany

**Andrés Fuentes,
Eckhard Wurzel,
Margaret Morgan**

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by
Andrés Fuentes, Eckhard Wurzel and Margaret Morgan

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ABSTRACT/RESUME

IMPROVING THE CAPACITY TO INNOVATE IN GERMANY

Key indicators show Germany belonging to the countries in the OECD with strong innovation activity even though some weakening in Germany's position relative to other OECD countries has occurred recently. While the redirection of resources towards unification-related spending as well as low economic growth have contributed to this development, more fundamental structural issues have also played a role. Germany has benefited less than other high-performing countries from the surge in new technologies, such as ICT and biotechnology, as innovation activities continue to focus on sectors, such as machinery and automobiles, in which Germany has a long record of strong export performance. Some features of the regulation of capital, product and labour markets are hampering the supply of risk capital, the creation of new firms and the reallocation of labour. In addition, firms are finding it increasingly difficult to recruit highly qualified labour. Measures to improve the framework conditions for innovation should include removing disincentives to take risks and to provide capital to new firms and raising the efficiency of the higher education sector. Furthermore, increasing the capacity of employment to adjust to technological change, raising the scope for competition overall, as well as reducing administrative opacity, would improve the capacity of the German economy to innovate and contribute to higher potential growth.

JEL codes: H25, I28, O30, O31, O33, O38, O52

Keywords : innovation, research and development, technological change, productivity, potential growth, business taxes, subsidies, tertiary education, intellectual property rights, competition, firm entry

Résumé

Selon les principaux indicateurs, l'Allemagne est l'un des pays de l'OCDE où l'activité d'innovation est soutenue, même si sa position relative s'est quelque peu dégradée ces derniers temps. Si ce phénomène peut s'expliquer en partie par un détournement des crédits vers les dépenses liées à l'unification et par la lenteur de la croissance économique, des facteurs structurels plus fondamentaux sont également intervenus. L'Allemagne a bénéficié moins que autres pays de l'explosion des nouvelles technologies, telles que les TIC et la biotechnologie, l'activité d'innovation restant axée sur les secteurs dans lesquels l'Allemagne obtient depuis longtemps de très bons résultats à l'exportation. Certaines caractéristiques de la réglementation des marchés des capitaux, des produits et du travail freinent l'offre de capital-risque, la création de nouvelles entreprises et la redistribution de la main-d'œuvre. De plus, les entreprises ont de plus en plus de mal à recruter des travailleurs très qualifiés. Pour créer des conditions plus favorables à l'innovation, il faudrait supprimer les contre-incitations à la prise de risque et au financement de nouvelles entreprises et renforcer l'efficacité de l'enseignement supérieur. Par ailleurs, en améliorant la capacité de l'emploi à s'adapter aux changements technologiques et en exposant davantage l'économie à la concurrence, ainsi qu'en luttant contre l'opacité de l'administration, on renforcerait la capacité d'innovation de l'économie allemande et on contribuerait à accroître son taux de croissance potentielle.

JEL classification : H25, I28, O30, O31, O33, O38, O52

Mots clés : innovation, recherche-développement, changement technologique, productivité, croissance potentielle, impôts aux entreprises, subsides, éducation tertiaire, droits de propriété intellectuelle, concurrence, entrée des entreprises

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IMPROVING THE CAPACITY TO INNOVATE IN GERMANY

By **Andrés Fuentes, Eckhard Wurzel and Margaret Morgan**¹

1. Reviving the dynamism of the German economy requires policy measures that strengthen productivity growth. Total factor productivity growth -- the growth in output, which can be achieved given all inputs combined -- decelerated in Germany in the 1990s, as it did in several other countries within the OECD. Innovation is a key element stimulating total factor productivity. This, in turn, can potentially spur higher employment of both capital and labour, which is a source of higher economic growth in its own. Indeed, empirical studies establish a strong positive relationship between research and development (R&D) and per capita GDP growth.² Indeed, “innovation” spans a wide range of activities ranging from invention to its diffusion and related organisational changes (**Box 1**), with private firms being the main actors in Germany (**Box 2**). While several factors impact on innovation in a complex way -- with knowledge about relevant interactions often still being quite limited -- regulatory reform of product, capital and labour markets can have significantly beneficial effects on innovation. This Paper aims at highlighting a number of policy issues affecting innovation and proposes options to improve framework conditions so as to raise the capacity of the German economy to innovate. Setting framework conditions conducive to innovation is also a necessary ingredient for government spending for innovation to be effective. The German government plans to increase public spending from 0.8 per cent of GDP in 2002 to 1 percent by 2010. Since a large part of R&D spending is on personnel this requires, *inter alia*, that framework conditions support the supply of high-qualified research personnel. By contrast, regulatory supply constraints -- also with respect to new firms -- would risk wasting resources.³ The next section of the Paper provides an overview about stylised facts that position German innovation performance in an international context. The following sections examine important aspects of the German economy which are relevant for innovation. This concerns product, capital and labour markets as well as taxation and the tertiary education system. The final section highlights a few aspects that are relevant for government support to enterprises.

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1. This paper was originally produced for the *OECD Economic Survey of Germany* published in August 2004 under the authority of the Economic and Development Review Committee. Eckhard Wurzel, Andrés Fuentes and Margaret Morgan are the head of, the economist, and the research assistant at the Germany/Austria Desk in the Economics Department. The authors are indebted to Andreas Wörgötter, Val Koromzay, Andrew Dean, Jorgen Elmeskov, Nigel Pain, Bernard Hugonnier, Peter Scherer and Gernot Hutschenreiter for their valuable comments. Researchers from the DIW and ZEW institutes in Germany provided valuable insights. Special thanks goes to Ernst Röder-Messell for research assistance and to Susan Gascard and Sheila McNally for technical preparation.
 2. A one per cent increase in a country’s R&D spending was estimated to generate an increase in total factor productivity of 0.1 and 0.3 per cent, see Guellec and van Pottelsberge (2001), Nadiri (1993) and OECD (2003a).
 3. See Sheehan and Wyckoff (2003) for analysis on implications of boosting government R&D spending for the demand for high-qualified personnel.

Box 1. Innovation -- concepts and data

What is "innovation"?

Innovation comprises activities which eventually lead to the introduction of new products -- "product innovation" -- or the introduction of new production techniques -- "process innovation". Innovation thus spans a wide range of diverse activities, including, for example, basic research, the acquisition of new production equipment or the invention of a new medicine. Innovation covers, in principle, both the application of existing knowledge in a new setting as well as the production of new knowledge.¹ Empirical evidence shows that the application of existing technology -- for example, ICT -- requires additional innovations to generate productivity gains, such as changes in work procedures and the organisation of production processes.² Innovation is a main driving force for economic growth. It generates higher income levels directly by increasing the productivity of inputs in the production process (total factor productivity). In addition,³ improvements in total factor productivity motivate capital deepening which also contributes to economic growth.

What are characteristic innovation processes?

The characteristics of the innovation process differ across different types of industrial activity. Empirical evidence⁴ suggests that industrial innovation patterns might be characterized either by *radical* innovation or *cumulative* innovation.⁵ Firms innovating in a *cumulative* way build on previous innovation efforts in an incremental fashion. Fundamental changes in the technology are less frequent. *Cumulative* innovation is therefore more likely in technologies with a well-established technological platform. *Cumulative* innovation often builds on firm- or individual-specific competencies. Specific competencies may be important in the innovation process, for example, when skills are costly to be codified (and thus costly to be transferred), or when they are embedded in complex organizational routines.⁶ *Cumulative* innovation helps firms erect barriers to entry tending to generate a prevalence of established firms in the innovation process. Technological stability tends to be reflected in stability of the hierarchy of firms contributing to innovation and thus in high concentration in innovating firms.

If innovation is *radical*, fundamental changes in technology occur at high frequency, so they are more likely to predominate in new technologies (e.g. biotechnology). This innovation pattern is characterized by *creative destruction*, with a large contribution of entry of firms in the innovation process which replace firms whose technologies become obsolete. Technological instability is reflected in more frequent changes in the firms which contribute to the industry's innovative output.

While innovation in specific industries does not always clearly fall under either type of innovation, automobile manufacturing, the chemical industry and parts of machinery production -- which make up a large proportion of German exports -- are generally considered to be characterized by *cumulative* innovation.⁷

How is innovation measured?

The main indicator used to measure innovation inputs is spending on R&D, often expressed as a share of GDP. For Germany, R&D spending has been estimated to cover about 50 per cent of spending on innovation. R&D spending is often considered a useful indicator of overall innovation effort, assuming a positive correlation between the two.⁸ Total R&D spending data are available in time series that are fairly comparable across countries. However, the widening in the coverage of R&D surveys in some countries affects the comparability of business R&D spending in the service sector.

Manufacturing industries are classified in *high*-, *medium-high*, *medium-low* and *low-tech* industries, depending on their R&D intensity. *High tech* industries have the highest R&D intensities. R&D intensity is measured as R&D spending relative to turnover or relative to value added.⁹ New technologies, such as ICT and biotechnology, fall into the category of *high tech* industries. The traditional German export industries -- automobile manufacturing, chemicals and machinery -- are medium high-tech industries

The main indicator of the output of innovation processes are patent statistics. However, individual patents differ considerably from one another in usefulness, and thus in value, and the propensity to use patents to protect inventions also differs across industries. For example, survey evidence from Germany indicates that more than 30 per cent of innovating firms engaged in transport manufacturing (including production of automobiles) and in the machinery

manufacturing sectors use patents to protect their inventions, whereas this is true for less than 5 per cent of innovating firms in the ICT and service sector industries.¹⁰ Also, patent coverage varies considerably across countries and over time, partly being the result of changing regimes of intellectual property right protection. This Paper draws on “triadic patent family” statistics, with approved patents broken down by the nationality of the applicant.¹¹ These are applications for patents at the three most important patent offices in the world,¹² so that they are likely to have substantial economic value. Patent families also help to prevent “home bias” in international comparisons of patent statistics, as innovators are more likely to file patents at their own country’s patent office. It turns out that patents are closely correlated with R&D spending.

Surveys of enterprises provide additional information on both inputs and results of innovation in the enterprise sector based on self-assessment. However, time series of data generated by these surveys in Germany are short and can for the most part not be compared to data from other countries. Cross country comparable survey data have been analysed for the EU for 1998-2000 and changes in survey design limit their comparability over time. These surveys provide information on, for instance, spending on all innovation activities. Innovative output measures provided by these surveys include cost reductions achieved as a result of innovations and proportions of sales of new products in total turnover.

In addition, data on the spending on new technologies, notably ICT, provide information about the extent to which the economy is able to incorporate existing knowledge in production processes.

-
1. Products and production techniques are typically defined as innovative if they are new to the respective firm, rather than new to the world or to the market in which the firm operates. See the definition of innovation in the European innovation surveys (European Commission, 2001, 2003).
 2. See e.g. Licht and Moch (1999) and Hempell (2002a, 2002b).
 3. See, e.g. Jones (1998).
 4. Using principal component analysis. See Breschi, Malerba and Orsenigo (2000), Malerba and Orsenigo (1997).
 5. Following the terminology in Soskice (1997). Bassanini and Ernst (2002a, b) use the terms entrepreneurial instead of radical and routinized instead of cumulative.
 6. See Bassanini and Ernst (2002b) and the references therein.
 7. See, e.g. Breschi et al (2000).
 8. See, e.g. Legler (2003).
 9. See OECD, 2003b and Legler (2003). Notwithstanding differences in the criteria to determine R&D intensity, the actual classification of industries is similar across methods used.
 10. Rammer (2003).
 11. If several applicants have different nationalities, the patent is attributed proportionally to the countries of origin of the applicants. Patents are attributed to the year in which the first approval is granted (“priority date”).
 12. The European, Japanese and US patent offices.

Box 2. Key players in German R&D

The enterprise sector accounts for about two thirds of total R&D spending in Germany. As of 1999, it provided about 7 per cent of the funding to the public research institutions, while the government financed about 5 per cent of private sector-conducted R&D for civilian purposes. Germany occupies a middle position in comparison to other high-income countries with respect to the size of these cross-sector flows. The bulk of private sector R&D is conducted by large enterprises.

Germany's federal structure gives rise to a complex institutional structure of public research. Most of the R&D financed by the public sector is conducted by the public research institutions, about half of which by universities. The largest of the institutes is the *Helmholtz Association of German Research Centres* (HGF) which conducts long-term oriented basic research in key technologies and includes large scale research facilities. The *Max Planck Society* also conducts basic research in selected areas, comprising 80 institutes. The 79 institutes of the *Leibniz Association of Research Institutes* conduct research in a broad range of disciplines. The *Fraunhofer Society* consists of 57 institutes. Its main objective is to promote technology transfer to industry. 40 per cent of its funding is through contract research from enterprises. All research institutes are co-financed by the federal government and the respective states at varying rates and are independent from the federal government. In addition, the federal ministries and the *Länder* run more than 200 research laboratories. These offer routine services, such as measuring, testing and standardization, and are also engaged in applied research.

According to evidence from the European Innovation survey few enterprises in Germany report a lack of technological knowledge as a factor limiting their innovation activities. Evaluations of the four research associations, conducted by ad-hoc commissions between 1996 and 2001, noted that the research output in most research institutes is often excellent and internationally competitive. A few institutes whose performance was found lacking were subsequently closed or restructured. However, the evaluations also noted scope for allocating a larger proportion of research funds through competitive tendering among institutes. Also, the research laboratories of the federal and *Länder* ministries have not comprehensively been subjected to evaluation.

The volume of government funding for the Fraunhofer institutes from the government is linked to success in obtaining research contracts from the private and public sector, allowing the institutes to both engage in basic research and technology transfer to private sector enterprises. Patented innovations of Fraunhofer institutes are often developed within projects financed by industry. The financing mode appears to be successful, as reflected in a nine fold increase of turnover compared to the 1960s and a strong patenting record. To secure the efficiency of the financing system in the future, agents should continue to observe that the output of the institutes are offered at market conditions.¹

The government has taken steps to increase the scope for competition for research funds among institutes and plans to subject all research laboratories of the federal ministries to evaluation. A timetable of regular reevaluations would further strengthen incentives for performance. The independence of evaluation commissions should also be ensured.² Steps should be taken to ensure market-determined prices for the use of patents of public research institutes.

1. See Rammer *et al* (2004).

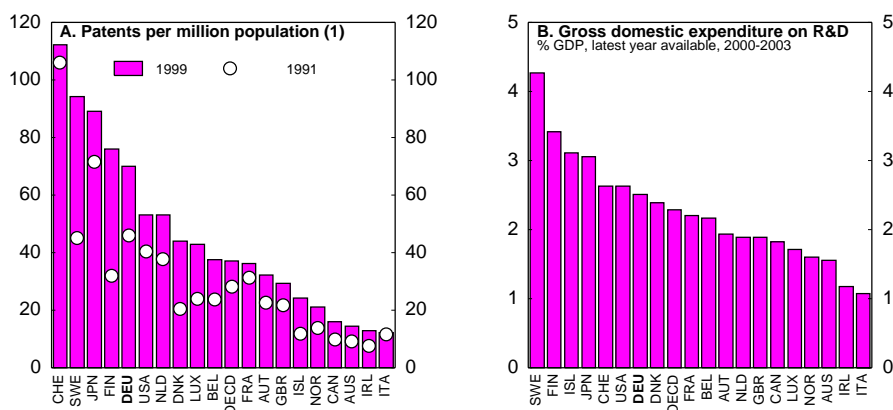
2. The evaluation of the Fraunhofer Institutes included representatives of German industry.

Innovation in Germany -- stylised facts

Innovative activities in Germany are strong...

2. Key indicators show Germany belonging to the countries in the OECD with strong innovation activity, as reflected in one of the upper ranks in the number of patents filed per population and above average levels of R&D spending in terms of GDP (**Figure 1**). Similarly, survey information from the *European Community Innovation Survey* on the proportion of enterprises reporting product or process innovations places German manufacturing firms second, behind Ireland, and first in services, while it ranks third in the proportion of turnover spent on innovation in both manufacturing and services.⁴ Germany is also one of the most attractive destinations for foreign-based R&D activities and R&D intensive industries contribute a larger share to exports in Germany than in OECD countries on average.⁵

Figure 1. Innovation activity



1. Patent families filed at the European Patent Office, the US Patent and Trademark Office and the Japanese Patent Office. Data for 1999 are OECD estimates.

Source: OECD, Patents and Main Science & Technology Indicators Databases.

3. A relatively large proportion of patenting and R&D spending in Germany takes place in industrial sectors with a long-standing record of strong export performance. Patenting is largely concentrated in transport equipment (including automobiles), machinery, and in the chemical manufacturing industries, where concentration has increased further in recent years relative to other countries.⁶ These industries are predominantly characterised by cumulative innovation patterns. Almost all industries with a high share in German patenting are *medium-high-tech*. A relatively small proportion of innovative activity, by contrast, is devoted to *high-tech* industries.⁷ Innovation activities have also started to play an important role in eastern Germany (**Box 3**).

4. Eurostat (2004). Participating countries include the EU-15 countries, Iceland and Norway.

5. See Belitz (2003), OECD (2003b).

6. The use of patents to protect innovations appears to be particularly widespread in the sectors where Germany performs strongly. This might explain to some extent why German patenting figures suggest a better performance, relative to the OECD, than its R&D spending.

7. See Frietsch and Breitschopf (2003) and Legler (2003).

Box 3. Innovation in the new *Länder*

Research-intensive sectors in the east contributed over-proportionately to the strengthening of eastern Germany's export market share. In manufacturing, since the middle of the 1990s export turnover of these sectors increased by some five percentage points more rapidly per year than the manufacturing average.¹ Between 1998 and 2002 production in research intensive sectors in manufacturing rose at an average annual rate of 8 per cent, as opposed to 5.9 per cent in eastern German manufacturing overall. In comparison to the west, manufacturing production in research-intensive sectors expanded more strongly, although the growth differential in favour of the east is larger in sectors that are not research-intensive.²

Empirical investigations also show that on the level of enterprises whose characteristics are comparable between the new and the old states research activity in the east is higher, largely owing to substantial government support. Eastern German research intensity is lower on the macro level, however: The share of the research-intensive sectors in industrial value added is almost 10 percentage points smaller in the east than in the west, and employment shares are significantly smaller than in the old states.

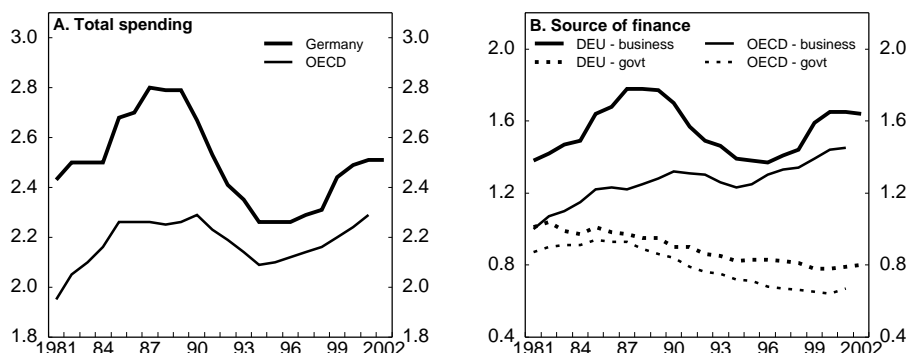
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1. There is still a considerable gap between the export share in comparison to the west, however. While the export share in research intensive sectors stands at some 40 per cent in the new states it is 54 per cent in western Germany. See: Deutsches Institut für Wirtschaftsforschung (2003).
 2. See Beer (2004).

... but appear to have weakened somewhat

4. However, there are signs that innovative activity has weakened somewhat. In terms of R&D spending as a share of GDP Germany has lost its leading position among OECD countries since the beginning of the 1990s. Spending dropped by some 0.3 per cent of GDP while it increased in the OECD as a whole (**Figure 2, Panel A**). Business-financed R&D spending accounts for this relative decline, as it fell in the first half of the 1990s without fully recovering later to its former level. R&D spending of the government sector, net of public sector enterprises, also declined as a share of GDP over the last twenty years, but not more so than in the OECD at large (**Figure 2, Panel B**).⁸ Patenting statistics also suggest some weakening in Germany's relative position (**Figure 1, Panel A**), although German patenting growth was well above the OECD average between 1991 and 2001, and exceeded patent growth in the US and Japan.⁹ The country's position as a recipient of R&D spending of foreign-based US enterprises dropped from first to second (after the UK).¹⁰

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8. Some OECD countries, including the US and the UK, also improved tax advantages of R&D spending substantially in the 1990s. These tax advantages are not included in public-sector financed R&D figures.
 9. According to the overall proportion of innovating firms in the *EC Innovation Surveys* of 1996 and 1992 Germany's position moved from second to third. Survey data are not consistent across years, so that only rank comparisons are used (European Commission, 2001).
 10. BMBF (2001).

Figure 2. Development of R&D spending
Gross domestic expenditure on R&D as a percentage of GDP¹



1. Data up to 1990 is for western Germany only. Business source means financed by private and public enterprises and institutes serving such enterprises. From 1992 onwards, government finance for Germany includes the private non-profit sector.

Source: OECD, Main Science & Technology Indicators Database.

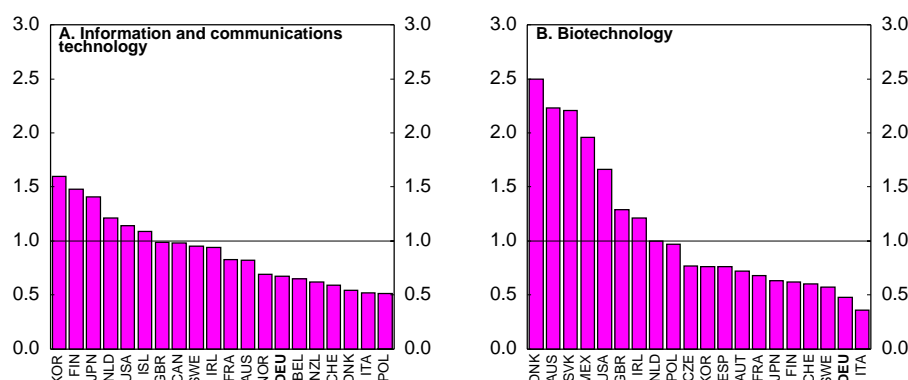
5. To some extent the drop in innovative activity in the first part of the 1990s relates to the effects of reunification. R&D spending dropped as resources in both the public and the private sectors were shifted towards unification-related spending.¹¹ Weak economic growth commencing in the first half of the 1990s and temporarily squeezed profits are also likely to have adversely affected R&D spending. Structural factors contributed to the relatively slow recovery of German R&D activity as well. In the OECD as a whole, high-tech industries -- such as ICT and biotechnology -- experienced much faster growth in innovation, as reflected in patents, than other sectors. Therefore, countries devoting a relatively large proportion of their R&D spending to high-tech industries, such as Finland, Ireland, Canada and the US, also tended to experience larger increases in overall R&D spending as a proportion of GDP.¹² By contrast, Germany devoted a much smaller proportion of its innovation effort to high-tech industries than the OECD average.¹³ The shares in patent applications of ICT and biotechnology are below the averages of both the OECD and the EU (Figure 3). Thus, Germany's share in the R&D surge in new high-tech technologies was moderate, contributing to the decline of its R&D spending relative to others.

11. See also Legler (2003).

12. See Frietsch and Breitschopf (2003), p. 45. The authors also show that the lack of specialisation of German patenting in fast-growing sectors depressed patent growth in Germany. See also: OECD (2003b).

13. A relatively small proportion of R&D spending is devoted to high-tech industries (OECD, 2003b).

Figure 3. Innovation in 'high-tech' industries
Specialisation index, average 1992-2000 (1)



1. Share of country X (in OECD total) in ICT or biotechnology divided by share of country X (in OECD total) of all patent applications to the European Patent Office. Index greater than 1 indicates relatively specialised.

Source: OECD, Main Science & Technology Indicators Database.

6. At the same time, Germany's world export market share in pharmaceuticals declined substantially since the beginning of the 1990s (**Box 4**). Medium-high-tech industries have a long record in Germany's strong export performance, and attract the largest share of German R&D spending and patenting. Nevertheless, Germany's export shares in machinery production also declined, most recently with the notable exception of automobiles. Mirroring this development, middle-income countries, such as Turkey, Korea, east European and Mediterranean countries, have reduced their comparative disadvantage in *middle-high tech* products, as reflected in diminishing net imports of these goods. Regarding high-technology goods, Germany remains a net importer.¹⁴

7. In Germany, firm entry has declined since the middle of the 1990s in both the new and the old states (relative to the labour force)¹⁵. The decline was particularly pronounced in the medium-high technology industries, in which the rate of new firm creation dropped by about a third between 1994 and 2001. By contrast, firm entry in the high-tech sector -- where firm entries are most likely to make a substantial contribution to innovation and productivity growth -- remained at about the same level as in 1993. Knowledge and technology intensive services recorded sizable increases in firm entry, though this did not fully compensate the losses in the medium-high tech field. As in many other European countries, employment growth rates of new firms appear much lower in Germany than in the United States. Moreover, entry rates in Germany appear to be relatively low, although cross country comparisons are difficult to make.¹⁶

14. OECD (2003b), p. 147.

15. ZEW (2003b). Declining East German rates reflect the end of the post-unification entry boom.

16. OECD (2003a). The sample is based on social security data for western German between 1989 and 1994. EUROSTAT has published firm entry data based on trade registration and deregistration which show relatively high firm creation rates in Germany between 1996 and 2000 if compared with other European countries. However, according to Eurostat, these German data are not comparable to those of other countries. For example, the German figures are likely to be inflated by registration of inactive firms, before 1999. See European Commission (2002b).

Box 4. The case of the pharmaceutical industry

Among the manufacturing industries in which Germany plays a leading role in world exports, the pharmaceuticals industry has fared least well relative to other main exporters (**Table 1**). The pharmaceutical industry has experienced substantial changes in innovation processes and, as a result, in marketing mechanisms. German firms adapted relatively slowly to these changes. For example, German pharmaceuticals were slower to divest non-pharmaceutical activities than their UK counterparts.

Table 1. Market share in world exports of selected industries
Top five exporters in 1991, per cent of world exports¹

	1991	1995	2002
Pharmaceuticals			
Germany	17.0	14.4	10.2
United States	12.1	9.2	9.8
Switzerland	12.1	10.6	9.6
United Kingdom	11.3	10.6	9.1
France	10.2	9.6	9.1
Chemicals excluding pharmaceuticals			
Germany	18.4	14.9	12.1
United States	15.9	13.9	13.6
France	10.2	8.9	7.2
Netherlands	7.3	6.4	5.0
Japan	6.7	7.2	6.2
Machinery			
Germany	20.2	17.2	16.1
United States	16.1	15.1	16.3
Japan	14.0	15.1	10.4
Italy	8.7	8.3	7.9
United Kingdom	7.4	6.1	6.2
Vehicles			
Japan	18.5	16.5	13.4
Germany	18.2	15.7	16.7
United States	16.8	14.1	13.8
France	8.8	8.7	8.1
Canada	7.3	8.6	8.1

1. World exports measured in current US dollars.

Source: UN COMTRADE Database.

In the 1980s innovation strategies shifted to biotechnological techniques, replacing to some extent traditional chemical methods. These radical innovations in biotechnology have created strong incentives for new entry and much research is taking place in start-ups rather than established firms. In addition ongoing research in any one complex disease follows various distinct research trajectories. As a result of shortened product life cycles new distribution channels developed, requiring dramatically different competencies.¹

Biotechnology start-ups developed relatively slowly in Germany, compared with the UK whose pharmaceutical industry expanded rapidly. This difference is not attributable to price regulations as both countries have high generic drug penetration rates and firms are free to set prices of newly patented drugs. Relatively strong regulatory restrictions on genetic research in Germany are likely to explain part of the difference. Indeed, regulations were relaxed since 1993, while still being stricter than in the UK, and EU rules governing innovation in the pharmaceutical industry were harmonised in 1995. In recent years the number of German biotechnology firms has increased rapidly. Institutional factors such as stricter regulation in Germany might also have influenced different patterns of firm growth. While German pharmaceutical firms expanded mainly via acquisition of firms abroad, British firms mostly grew internally or through UK-based mergers.

1. See Casper and Matraves (2003).

Regulatory reform interacts with innovation

8. As outlined in the preceding section, key indicators point to Germany as a very innovative economy. Innovation activity appears largely concentrated on fields of traditional strength on export markets. By contrast, there is evidence that a smaller proportion of innovation activities are devoted to high-tech fields than in some other economies competing with Germany. Similarly, Germany has been less

able than a number of other countries within the OECD to reap the benefits of ICT for raising the productivity performance in other industries (**Box 5**). Regulatory features of product, capital and labour markets affect an economy's capacity to innovate via various channels and may benefit different economic sectors to differing degrees. Interactions are often complex, and knowledge on their impact is deficient. Nevertheless, theoretical and empirical evidence allows a number of policy conclusions that are important to foster innovation. For example, empirical work suggests that administrative regulation can have significant adverse effects on the creation of enterprises, stemming not only from specific barriers to entry but also from administrative opacity more generally.¹⁷ New firms make an important contribution to innovation because they can enter a market with the most productive combinations of inputs and, unlike established firms, do not incur adjustment costs when adopting new technologies and work practices.¹⁸ Examples for such costs include making redundant or retraining employees, replacing machinery, or reorganising management procedures. Moreover, new firms create competitive pressures on existing firms, inducing them to innovate and improve performance, and lead to the replacement of obsolete firms. Accordingly, firm entry spurs innovation, contributing particularly strongly to productivity growth in "high-tech" sectors, notably in ICT-related industries.¹⁹ Thus, regulatory reform fostering entry might be particularly effective in high-tech sectors. The example also shows that interactions between different regulations can play an important role. The contribution of enterprise start-ups to total factor productivity is likely to be larger the more stringent the employment protection regime is. This suggests that easing the regulatory environment for firm entry is likely to be of particular importance for the diffusion of innovation in countries where established firms face high costs of adjusting their production processes.

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17. The absolute cost of administrative regulation to enterprises is often invariant with respect to firm size so that the implied burden weighs more heavily for entering firms, which tend to be relatively small.
 18. *E.g.*, Mortensen and Pissarides (1994).
 19. Scarpetta *et al.* (2002). In addition, firm entry rates are above-average in ICT-related industries and services as well as pharmaceuticals OECD (2003a), Chapter 4, and Brandt (2004).

Box 5. The ICT sector in Germany

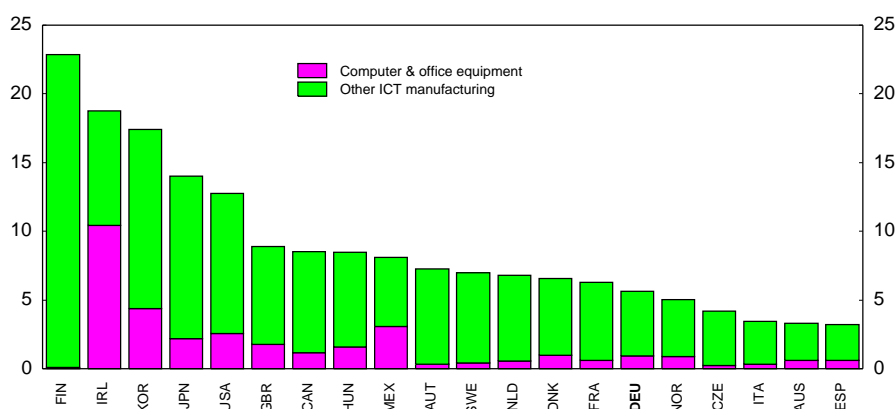
Rapid innovation has turned ICT into an important source of productivity improvements, through both the production and the use of ICT goods. Often the gains from the use of ICT appear to exceed those of ICT production. Specifically, ICT spurs economy-wide productivity growth via three channels:

- Acceleration of productivity in the ICT producing sectors themselves and a growing size of the ICT producing sector
- Increased use of ICT equipment in the production of other goods
- Spill-over effects from the use of ICT, arising as a result of complementary innovations, e.g. in work practices or organization, as ICT equipment is introduced¹

Production of ICT goods and ICT has been less vivid in Germany than elsewhere ...

Productivity growth in manufacturing of ICT goods has increased more strongly than in other industries in Germany, broadly mirroring similar developments in other countries. However, the share of ICT goods in manufacturing production in Germany is relatively small (**Figure 4**). This holds similarly for the share of ICT production in GDP. Moreover, recent growth of the sector does not suggest any catching up. Comparisons of the production of ICT services across countries are subject to considerable uncertainty due to differences in measurement. Available information suggests, however, that Germany occupies a middle rank.² The share of German innovation efforts devoted to ICT, as measured in R&D spending and the proportion of patents devoted to ICT is also relatively small.³

Figure 4. Share of ICT in manufacturing value added, 2000¹
Per cent



1. Or latest available year. Other ICT manufacturing includes communication equipment, insulated wire and cable and precision instruments.

Source: OECD, STI Scoreboard 2003.

... which is also true for the application of ICT

Benefits from productivity improvements associated with ICT can be reaped by application of ICT goods without own production.⁴ Nonetheless, the proportion of GDP spent on the acquisition of ICT equipment (hardware and software) in Germany of about 6½ per cent falls short of that in several other countries within the OECD, such as Finland (7 per cent) and the United States (above 8 per cent).⁵ Relatively moderate spending on ICT is likely to account to some extent for the relatively small contribution of quality improvements in the capital stock (embodied technological change) to total factor productivity growth in Germany, as ICT is an important source of such quality improvements. Notably the US and Finland recorded substantially higher contributions of embodied technological change to total factor productivity than Germany (OECD, 2003a).

Moreover, although German industries with intensive use of ICT technologies recorded higher gains in labour productivity than other sectors, productivity growth in these industries did not accelerate in the second half of the 1990s, unlike in the ICT-use intensive industries in the US. This suggests that German firms have not yet reaped the productivity benefits arising from innovations that are complimentary to the introduction of ICT goods as much as US firms did, possibly because German firms have been slower in embracing changes in organization and work practices

that would be required to fully take advantage of these benefits.⁶

... indicating scope for improvement in the policy framework

Some evidence suggests that the smaller degree of ICT capital deepening in Germany has been more significant than the smaller contribution of ICT production in explaining the relatively subdued overall contribution of ICT to productivity growth in Germany.⁷ Since Germany also occupies a middle position concerning household access to computer and internet, it is likely that not all of the reasons for slow diffusion of ICT are specific to the business sector.⁸ Moreover, the price differential of ICT investment goods *vis-à-vis* the US declined substantially in the late 1990s to about 7 percent and is now among the lowest in the OECD.⁹ Hence, a comprehensive picture of the forces preventing higher rates of innovation, investment and utilisation of ICT is difficult to obtain, but structural factors related to product and labour market regulations are likely to play a significant role.

- *Regulation of firm entry:* Firm entry is considerably more important in ICT manufacturing industries and services than in the business sector as a whole.¹⁰ Empirical evidence also shows that firm entry spurs productivity growth strongly in the ICT producing sector. Moreover, new general-use technologies, such as ICT, are more quickly diffused by new firms or firms with new management and organization, as these, unlike incumbent competitors, do not face the costs of changing existing organization and technology. In the second half of the 1990s Germany was among the OECD countries with the highest level of administrative burdens to start-ups.¹¹
- *Regulation of telecommunications:* Broadband access to the internet is likely to provide scope for productivity improvements in e-commerce. Lack of competition between the various broadband technologies appears to be limiting the use of broadband, as the incumbent telecoms operator, *Deutsche Telekom*, adopted a pricing strategy for DSL services which inhibited market entry by competitors, although more recently resale contracts between Deutsche Telekom and market entrants have been increasing competition within the DSL sector.¹²
- *Product market regulation:* High intensity of competition in product markets forces firms to adopt new production technology more rapidly in order to increase productivity. Compared to the United States, German product markets are noticeably more regulated, reducing scope for experimenting with changes in business organization which would help generating productivity gains from ICT use.
- *Lack of ICT-specialists.* Human capital plays an important role in realizing productivity gains from ICT use. Life-long learning helps match the skills of workers to new technologies such as ICT. The proportion of highly skilled ICT workers in the workforce in Germany is below the EU (15) average, and so is its growth. One third of German enterprises state that lack of ICT skills is preventing ICT investment. Participation in life-long learning in Germany is low in international comparison.¹³
- *Labour market regulation:* Countries with labour market institutions that support labour mobility and firm creation may be better equipped to innovate in industries characterized by multiple and rapidly evolving technologies including most of the ICT industry.¹⁴

1. See OECD (2003f), Hempell (2002) and Van der Wiel (2001).

2. OECD (2003b). The comparison is based on ICT services include ICT equipment, telecommunications, computer and related services, as wholesaling and renting of ICT equipment are not available for Germany.

4. Colecchia and Schreyer (2002) provide illustrative evidence that the levels of ICT use and production are not correlated across countries.

3. OECD (2003b).

5. ZEW (2003c). Data from the European Information Technology Observatory which used nominal spending on ICT divided by nominal GDP. Spending in Germany was 0.2 per cent of GDP lower than the average of European countries consisting of the EU-15, Norway and Switzerland.

6. SVR (2003b).

7. See D. W. Jorgenson (2003), Figure 4. Jorgenson investigates only information technology rather than information and communication technology. In Jorgenson's study of the G7 countries, the contribution from IT capital deepening was smaller than in the US, the UK and Canada but larger than in Italy and France. Differences in the measurement of ICT prices affect the growth contribution of ICT investment on real economic growth (see e.g. Deutsche Bundesbank, 2000, 2001 for an estimate of the effect on measured real GDP growth in Germany). However, the studies quoted here make use of harmonized ICT price indices in order to eliminate price measurement effects.

8. OECD (2003b). Comparable data refer to 2000 and 2001.

9. OECD STI Department. Unpublished data.

10. OECD (2003a) and Brandt (2004).

11. Bassanini and Scarpetta (2002); Nicoletti *et al.* (1999).

12. Gordon and RWI (2002), ZEW (2003c) and OECD (2003c).

13. See OECD (2003f), ZEW (2003c), Gordon and RWI (2002), European Commission (2003). 14. OECD, 2003a.

Protection of intellectual property rights and product market competition

9. Protecting intellectual property rights (IPRs) is important to raise incentives to innovate. While a key issue in the design of IPR protection is to find an efficient balance between raising the returns accruing to innovators by granting a certain degree of monopoly power and safeguarding the diffusion of innovation, evidence from surveys indicate that the degree of IPR protection within Germany is similar to the one in other high-income countries. Patent protection in Germany is among the strongest in the OECD, and the patent protection system has served as a model for other countries as well as for the European Patent Office.²⁰ The German system of protection for smaller inventions (*Gebrauchsmuster*), which do not qualify for patents, has also been adopted by many countries as it has been useful in encouraging incremental innovation and technological catch-up. In recent years further progress has been made in speeding up patent filing procedures in Germany, and the rights of producers to receive copyright fees have been widened.

10. To a large extent IPR protection worldwide -- as opposed to protection by national law -- is a relevant parameter determining the returns to innovation. IPR in Germany depends on policies of the European Union as well as the European Patent Convention, which established the European Patent Office.²¹ The monetary cost of filing a patent at the European patent office is about five times higher than at the patent office of the US, notwithstanding significant reductions in application fees since 1996. High costs are in part attributable to legal complexity, as infringement cases need to be brought before the national courts of each country for which the European patent has been granted.²² High costs are likely to weigh particularly heavily on small and medium-sized enterprises in Germany, as the proportion of small and medium sized enterprises which are engaged in innovation activity is large relative to other European countries.²³ The EU plans to introduce a "European Community Patent", linked with a European Community Patent Court. According to the European Commission, the European Community patent would be likely to reduce patenting costs substantially.

11. For a given level of IPR protection product market competition strengthens incentives to innovate, and therefore productivity growth. In a more competitive environment firms have to work harder to meet the performance of competing firms, providing incentives to adjust work organisation and technologies to adopt best practice. Overall, empirical evidence suggests that regulation of product markets inhibiting competition reduces R&D spending and is negatively correlated with total factor productivity growth.²⁴ There is considerable scope to improve competition in some sectors. This includes network industries such as the telecom sector, which is of particular importance for the ICT sector.

Reducing administrative over-head

12. Recent empirical work suggests that Germany occupies a middle rank among European countries (EU-15) with regard to the duration and cost of procedures to create a limited private company as well as with respect to the capital requirement for limited private companies.²⁵ Some OECD members outside the EU appear to have considerably lower start-up costs, notably New Zealand, Canada, Australia and the

20. See Park and Wagh (2002).

21. Member states of the European Patent Convention include the EU member countries as well as some European states that are not members of the EU.

22. Martinez and Guellec (2004),

23. European Innovation Survey. European Commission (2002b).

24. Bassanini and Ernst (2002a).

25. See European Commission (2002a).

US.²⁶ One factor raising start-up costs for incorporated business in Germany appears to be multiple administrative contact points.²⁷ While start-up times and costs are relatively low for private partnerships,²⁸ the duration of business registration appears to be unnecessarily long, exceeding two months in about 70 per cent of registrations. There is also some indication that firm exit costs are on the high side: while reported duration of bankruptcy procedures is relatively low in comparison with other high-income OECD countries, associated costs appear to be above average.²⁹ Empirical evidence also suggests that the duration of creditors' access to bankrupt debtors deters firm creation.³⁰ The duration seems to be relatively long in Germany in comparison to many other European countries and the United States.³¹ High exit costs have a negative impact on firm creation as firm closures are particularly likely among young firms.

13. Proliferating procedures contribute to administrative opacity, weighing particularly on small firms and therefore on firm entry and may favour established organised interests groups.³² Excessive regulation is likely to contribute to perceptions among enterprises of overly time-consuming administrative procedures for granting permission to undertake investment projects, notwithstanding reductions in durations that were achieved in the mid 1990s.³³ Still, about 20 per cent of German enterprises state that insufficient flexibility of regulations or standards are hampering innovation, compared to less than 10 per cent for the average of countries participating in the European innovation survey. Similarly, the complexity of Germany's income tax system is likely to deter entry, as the costs of coping with complex tax rules are more difficult to shoulder for small firms. Indeed, surveyed small and medium-sized enterprises consider the simplification of tax legislation and the reduction of regulatory overheads one of the most important reform issues, with the smallest firms giving it the highest weight. Simplification of the tax code is considered more important than extending subsidies to the *Mittelstand*.³⁴

14. Hence, more efforts to simplify the administrative burdens associated with the foundation and growth of companies could enhance innovation. To this end one-stop shops should be established by regional governments, and regulations should be scrutinised and streamlined. While the government has launched an *Initiative to Reduce Bureaucracy*, profound deregulation also requires action on the side of the states and communities because sub-central authorities are often responsible in areas where administrative burdens are high.³⁵ Moreover, steps to reduce administrative costs associated with existing regulation should be complemented by steps to avoid unnecessary costs imposed by new regulation. Substantial simplification of Germany's income tax code could probably go a long way to reduce entry barriers.

26. World Bank (2003).

27. European Commission (2002a).

28. European Commission (2002a).

29. World Bank (2003).

30. Brandt (2004).

31. According to UNICE (2000).

32. OECD (2003c).

33. See, e.g. BDI (2003), IHK Hamburg (2002). IHK Hamburg reports on surveys of enterprises which indicate that commercial building permit applications took about four months to be completed in major German cities. 20 per cent of this time period lapsed between application and the onset of the administrative procedure, suggesting scope for reducing opacity in the application process.

34. Creditereform (2002) and *esbf* survey, quoted in Hommel and Schneider (2003).

35. For example, most of the measures suggested in a pilot project on reducing bureaucracy in the state of Bremen, which aims at identifying and testing scope for reducing administrative costs for Germany as a whole, require implementation by subcentral authorities. Freie Hansestadt Bremen, Handelskammer Bremen (2003).

Developing risk capital markets

15. Profits generated by innovation in the business sector typically arise with a time lag. Therefore, as is the case with investment decisions, the availability of financing is crucial for innovation decisions. Moreover, innovation decisions are, by their nature, particularly risky and the expenses are often not associated with the purchase of capital goods that can be collateralized. Also, the distribution of information is often highly asymmetric -- more so than is the case with investment -- as an innovating firm will be better able to assess the potential profitability of an innovative project than a provider of external finance. In particular, much innovation in high-tech sectors, such as biotechnology, relies on entry of new firms.³⁶ The large proportion of intangible assets (such as human capital or a new product idea) involved in innovation in these industries aggravates the asymmetry of information between the firm and a potential provider of finance so that credit and conventional equity financing are typically not provided to these start-ups. Venture capitalists fill the void, typically providing management services as well for these companies to overcome the informational problems. The scope for cross-country VC capital flows is limited since management services are not easily exported because they require local knowledge and presence.³⁷ Hence, well functioning markets for risk and venture capital are indispensable for innovation projects. In the same vein, the taxation of enterprises affects innovation not only through the overall tax burden it places on enterprises but also through its effects on the structure of financing and on risk-taking.

16. Venture capital financing is relatively small in scale in Germany, amounting to about one fifth of the level (expressed as a percentage of GDP) in the United States on average between 1998 and 2001. The size of the VC market is also smaller than in many European countries, notwithstanding generous public sector support, relative to the size of the market (**Figure 5**). The closure of the *Neuer Markt* stock exchange segment for young technology firms in 2003 was a blow to the venture capital industry, as the *Neuer Markt* provided about 75 per cent of the initial public offerings for VC-backed firms between 1998 and 2000.³⁸ Both supply and demand factors are likely to contribute to the small size. The preponderance of cumulative innovation in established firms is likely to reduce the demand for VC. However, net outflows of VC managed in Germany have been close to zero, suggesting that domestic supply factors are also at work.³⁹

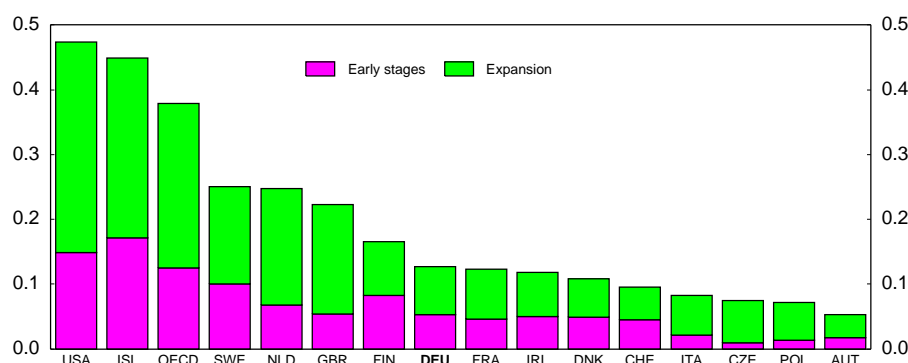
36. See *e.g.* ZEW (2003a).

37. This refers to the flows of capital from venture capital firms to start-ups. Venture capital firms themselves may still raise funds from foreign investors. Venture capital supplied by domestic venture capital firms largely determines how much venture capital is available to domestic firms, as reflected in the close correlation between the amount of VC raised and the amount of VC invested across countries. See also OECD (2003b).

38. Franzke *et al.* 2003.

39. Pension funds make a relatively small contribution to venture capital financing in Germany. In the UK or the US, by contrast, pension funds contribute a large proportion of VC funds, reflecting the more developed pension funds industry in these two countries in general. Private pension assets have reached 60 per cent of GDP in the UK and US, but only 17 per cent in Germany. Moreover, in Germany at least a third of private pension wealth is kept as retained earnings by enterprises within occupational pension schemes (see Yermo (2003) and FAZ (2003)). In the US, permission for pension funds to invest substantial amounts into risky funds, including venture capital, contributed to the expansion of the venture capital market. More than half of the funds at the disposal of German venture capitalists is provided by banks, considerably more than in the UK and the US. As a result of bank ownership of venture capital firms, venture capitalists in Germany may have less expertise which is specific to the sector in which their client firms operate (see Schertler and Stolpe (2003)).

Figure 5. Managed venture capital investment, 1999-2002¹
Per cent GDP



1. Total investment flow over period. Venture capital investment in country *i* is investment managed by venture capital funds located in country *i*, it is not the amount invested in country *i*.

Source: OECD, based on data from EVCA (Europe) and NVCA (United States).

17. In particular, a liquid stock market is crucial for the supply of venture capital as it provides an efficient exit channel for venture capitalists having financed start-ups.⁴⁰ Hence, broadening the stock market would support the emergence of a more active VC market. However, initial public offerings on the stock market are small in Germany, and the number of joint stock companies has been falling steadily for several years. The small number of German firms listed on the stock market has been attributed *inter alia* to the traditional preponderance of universal banks. Universal banks may have relatively higher opportunity costs to engage in the issue business,⁴¹ which may substitute their loan business. The fact that local and state governments act as guaranteeing authorities for public sector banks might also have played a role. Such guarantees lower the cost of capital, which is likely to induce banks to extend credit at less stringent conditions than would prevail if competition were undistorted. Government guarantees are being phased out over the next years.⁴² Legislation came into force in February 2004 facilitating activities of investment funds. *Inter alia*, capital requirements for investment funds were reduced and hedge funds can now be issued. Supervision of investment fund providers was also simplified. These measures support the development of equity markets, although policies could be more pro-active. Future reforms could address legal requirements for setting up a joint stock company (*Aktiengesellschaft*) so as to foster the formation of small listed corporations.⁴³

18. A number of tax rules generate disincentives for venture capitalists to provide management services to their client firms and reduce incentives to invest in start-ups rather than established firms. Similarly, some rules hamper investment in equity capital and the broadening of equity capital markets.

- Under certain conditions investors are not taxed on the gains from the sale of a company's equity in the venture capital firm's portfolio if the venture capital firm does not supply management services to the client firm. By contrast, if management services are supplied, the gains are

40. Divestment through the stock market provides an opportunity for the venture capitalist to signal its success and for the entrepreneur to regain control of the company. See Black and Gilson (1998).

41. According to Monopolkommission (1998).

42. See OECD (2001a).

43. See Franzke *et al.* (2003).

typically taxed as business income.⁴⁴ In addition, the gains then become liable to the business tax which is likely to discourage foreign investors.⁴⁵

- While capital gains on stock options in large established firms, used as an incentive device for management, are typically not taxed, performance incentives for the managers of venture capital firms (carried interest) are subject to income tax. New legislation, effective from July 2004 onwards, reduces this difference in tax treatment of performance incentives between managers of venture capital firms and managers of large established firms, subjecting half of the carried interest to taxation.
- Business angels -- wealthy individuals investing in start-up firms who concentrate on developing companies at the seed stage -- are subjected to capital gains tax⁴⁶ whereas investors in private equity firms financing management buy-ins or buy-outs are typically tax exempt. This favours investing into restructuring of established firms over investment in start-ups.
- Limits on offsetting losses against gains from the sale of certain types of equity holdings used in start-up financing ("silent partnerships", *Stille Beteiligungen*) discourage providing capital for a start-up.
- Retained earnings of incorporated companies are taxed more favourably than distributed profits at the level of the individual investor. Since start-up firms cannot typically resort to retained earnings as a source of finance but depend on equity, this tax structure is also likely to divert flows from new to established incorporated firms.
- If the owner of a company changes, for example as a result of an initial public offering of a start-up, the company cannot, in general, offset previous losses against future profits for corporate income taxation purposes if a substantial amount of additional capital is injected into the newly acquired firm.⁴⁷ This provision discourages initial public offerings and innovation of start-ups expecting to raise external equity. The provision also discourages the supply of capital to firms after a trade sale or public offering.
- Inheritance tax rules favour non-equity ownership of enterprises as well as real estate over assets in equity. While this provision is meant to protect established small and medium sized enterprises, it might hamper the development of the equity market. The inheritance tax law is currently under review. A possible road of reform would be to harmonise taxation of the different types of assets while assigning the inheritance tax liability the status of subordinated debt. This would address the liquidity problems that can arise as a result of the inheritance tax liability.

44. Venture capital firms which do not provide management services above the monitoring activities of a shareholder are classified as private wealth managers. Investors in these venture capital firms are subject to capital gains tax on the sale of shares of the venture capital firm's client companies. The tax rules exempt capital gains from taxation if the investor's share of the client company, through the venture capital fund, is below 1 per cent and is kept for at least one year. Investors in a venture capital firm providing management services, by contrast, do not qualify for the tax exemption.

45. While domestic investors can offset the business tax against income tax, foreign investors cannot do so.

46. This is because their shareholdings tend to exceed the 1 per cent threshold. See footnote 44.

47. Losses cannot be offset against future profits if the acquired firm's assets are increased by more than 100 percent, unless the capital injection is necessary to ensure the survival of the firm.

- Calculations of the Council of Economic Advisers show that average effective tax rates are lower for private partnerships than for incorporated companies.⁴⁸ Empirical evidence indicates that owner-managed firms appear to have a lower propensity to innovate than firms with appointed managers, arguably because more widespread ownership spreads the risks stemming from innovative business strategies,⁴⁹ although limited liability might also encourage enterprises to take risks. The reductions in marginal personal income tax rates in 2004 and 2005 will increase the tax advantage of unincorporated companies further, reinforcing the need to modify company taxation.

19. Moreover, since returns on equity (both retained earnings and externally raised equity) of corporations resident in Germany are taxed more heavily in Germany than in major European countries, German parent companies have incentives to provide equity financing to foreign affiliates (while foreign firms face tax-induced disincentives to provide equity to affiliates in Germany).⁵⁰ This in turn might imply that capitalisation in Germany becomes thinner, which might hamper risk financing. Hence, tax rules should be modified and specific provisions abolished such that they cease to penalise early stage financing of start-ups and the involvement of venture capital firms in the management of start-ups, as well as to hamper the development of equity markets more generally. In the same vein, a recent sharpening of the limits to carrying forward losses might also be reconsidered as they might reduce the propensity to take risks and hence to innovate.⁵¹

Adapting labour market institutions and work practices

20. Institutional features of the labour market can have a significant impact on the structure of innovation and adoption of new technologies. Worker competencies that are firm-specific appear to play an important role in “cumulative” innovation. By contrast, firms engaged in more “radical” innovation are more likely to rely on adjustments of their workforce so as to adjust skill compositions or change work practices. Accordingly, industries in which innovation is mainly cumulative are more likely to benefit from incentives for firm-provided training, and to suffer less from the adverse affects of institutions that hamper the re-allocation of labour, than firms that are engaged in radical innovation (**Box 1** above). Indeed, countries with strict employment protection legislation combined with coordinated wage setting tend to concentrate their R&D spending on those industries where cumulative, as opposed to radical innovation predominates.⁵² At the same time, the evidence is that companies are more likely to realise substantial productivity gains from adopting new technologies, such as ICT, if they undertake complementary innovations in production processes or work organization.⁵³ Hence, labour market legislation that hampers reorganisation of production processes and work practices is likely both to reduce the realised productivity

48. SVR (2003a). Effective tax rates are calculated averaging over financing methods, using observed financing patterns as weights and include the tax burden of the local enterprise tax.

49. Czarnitzki and Kraft (2003).

50. See SVR (2003). The comparator countries include France, the UK, Ireland, Italy, the Netherlands, Sweden and Spain.

51. Specifically, losses from earlier years can be fully deducted from profits if the latter do not exceed € 1 million. Above this threshold losses can be deducted only up to 60 per cent of profits. As a result, for any given expected return, riskier projects are taxed more heavily. The adverse effect on risk taking associated with this measure will be larger for non-incorporated companies which are subject to the progressive marginal tax rates of income taxation, as higher profits resulting from successful innovations will tend to be taxed under higher marginal tax rates.

52. See Bassanini and Ernst (2002a).

53. OECD (2003f).

gains associated with the adoption of new technologies and to slow their diffusion. Similar effects are to be expected from labour market policies that discourage entry or growth of new firms. Indeed, the strictness of employment protection legislation (EPL) and the proportion of investment spending devoted to ICT are negatively correlated across OECD countries, suggesting that strict EPL, through increased adjustment cost, reduces the absorption of new technologies. This is particularly likely to hold if incentives for retraining of workers are insufficient to adjust to new skill requirements.

21. In Germany, several institutional features of the labour market tend to support the attachment of workers to firms and hence the accumulation of firm-specific human capital, notably the dual apprenticeship system, which is sustained by the absence of poaching of workers by other firms,⁵⁴ and relatively stringent EPL. These factors are likely to have contributed to the pattern of specialisation of German innovation in industries that are largely characterized by cumulative innovation. On the other hand, labour market institutions appear less adapted to support the reallocation of labour, which may have diverted activity away from areas with particularly rapid absorption of new technologies (**Box 5** above).

22. Adapting labour market institutions and work practices to new demands may pay off in terms of productivity gains associated with swifter adoption of new technologies or more active innovation in certain areas. For example, exempting small firms from dismissal protection is likely to contribute to the generation of innovations by facilitating creation of new firms. Quick adaptation of vocational training curricula to new market needs increases the attractiveness of plant-based vocational training and is necessary to support rapid diffusion of innovation. Progress on these and related scores has recently been made, but there remains scope for further reform.

Securing the supply of highly qualified workers

23. The supply of well trained and highly qualified labour is a key ingredient in the generation and diffusion of innovation. This includes the fact that the international location decision of enterprises is influenced by the availability of highly qualified employees and research personnel. Hence, securing a high performance of all segments of the education system is called for. Also, policies should foster the attractiveness of Germany for highly qualified labour from abroad.

24. Indeed, there is a secular trend toward employment with higher qualification, which Germany shares with other countries within the OECD. The share of those employed in German industry and the services sector with academic education increased by about a third since the beginning of the 1990s. In manufacturing, employment of persons with academic qualification increased substantially in absolute terms while overall employment fell significantly.⁵⁵ To a considerable extent this development appears to be related to the demand for personnel in R&D. The employment share of high-qualified personnel (as measured by academic and technical occupations) in German research-intensive industry and knowledge-intensive services exceeds the EU average significantly. Even so, the margin declined in the second half of the 1990s.⁵⁶ But there is evidence that even in periods of high general unemployment firms find it increasingly difficult to recruit highly qualified labour. For example, in a recent survey, sampling enterprises of all size classes in industry and among providers of technical services, some 42 and 64 per

54. See *e.g.* Casper and Matraves (2003).

55. For example, employment of high-skill workers has helped firms reap productivity gains from ICT use (OECD 2003f).

56. High-qualified personnel is measured by occupational ISCO-88 groups two and three (academic and technical or equivalent occupations). Within the EU the share of high-qualified personnel is higher only in Sweden, the Netherlands and Finland. See: special evaluation of employment by qualification, based on the EU Labour Force Survey, Bundesministerium für Bildung und Forschung (2000).

cent of the firms reported problems in filling vacancies for engineers in the recession and boom years, respectively, around the turn of the last decade. R&D turns out to be the main activity adversely affected, and 76 per cent of the firms concerned perceive a slowing of the innovation process as a consequence.⁵⁷ Most firms concerned (68 per cent) consider a lack of interest in taking up engineering studies as the main force behind the supply constraint. Migration of employees abroad, while seen as an issue, is considered the least important factor (19 per cent).

Efficiency in the tertiary education system needs to be raised

25. Tertiary graduation rates in Germany are among the lowest within the OECD (**Figure 6, Panel A**). The number of graduates declined since the middle of the 1990s, including those in science and engineering. After the middle of the 1990s, inflow into the university system picked up, from 28 per cent of the relevant age group in 1998 to 36 per cent in 2003. Still, inflow rates into tertiary studies are low by international comparison.⁵⁸ At the same time, average expenditures of tertiary education per graduate are among the highest within the OECD. Relatively long average study durations, especially at the universities,⁵⁹ are an important determinant behind this outcome (**Figure 6, Panel B**). At graduation, German students have about the highest age within the OECD. Drop-out rates from tertiary studies of about 30 percent, while about average among OECD countries, add further evidence that the efficiency of the system should improve. Indeed, long study periods tend to discourage investment in education unless they are matched by proportionate gains in productive capacity that are reflected in subsequent earnings. In general, the latter condition does not appear to hold, suggesting that studies may become less focused when they are stretched. Indeed, in Germany private financial returns on tertiary education are low by international comparison, and this relates largely to the long duration of studies.⁶⁰ Moreover, longer working lives would raise the returns to education.

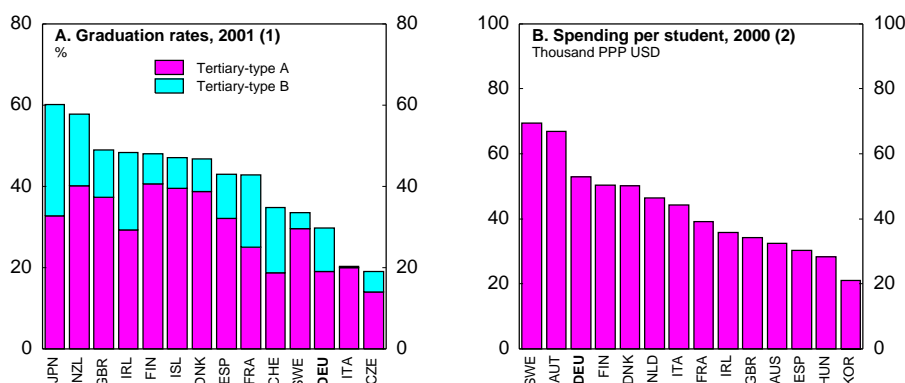
57. Zentrum für Europäische Wirtschaftsforschung (ZEW) and VDI Nachrichten (2004), Fachkräftemangel bei Ingenieuren – aktuelle Situation and Perspektiven.

58. See OECD (2003d).

59. Courses are shorter at the more occupationally oriented *Fachhochschulen* than at the academically oriented *Universitäten*.

60. See Blöndal *et al.* (2002). Incentives to invest in higher education are also likely to be strengthened if firm entry rates are high. New firms with the potential to expand are often set up by high-skilled workers. Opportunities to set up a business therefore increases highly skilled workers' job opportunities and reduces the job market risks highly-skilled workers are exposed to. The favourable effect of firm entry on the supply of skilled labour is backed up by cross country empirical evidence (Dullek *et al.*, 2003).

Figure 6. Graduation rates and spending in tertiary education



1. Rates are estimated as [number of graduates]/[population of typical graduation age]. Tertiary-type A programmes provide qualifications for advanced research or higher skill professions. Tertiary-type B programmes focus on practical, technical or occupational skills.
2. Cumulative spending on educational institutions over study duration (average duration of tertiary studies).

Source: OECD, Education at a Glance 2003.

26. Over the last years, the importance of securing high standards of university education has increasingly been recognised in the policy debate, and induced reforms in some areas. In particular, to shorten study times, universities were given the option to offer bachelor and master degrees, and by 2010 these will become mandatory. A system of national quality assurance by accreditation has been introduced for the new bachelor and master degrees, in line with EU requirements. Also, the new career path of a “junior professorship” was introduced, and the requirement in several disciplines to produce a second thesis (*Habilitation*) as a prerequisite for a full professorship will be phased out by 2010. Some part of the pay for professors with tenure has been made performance dependent. These changes are perceived as insufficient by policy makers, and the government plans now to create a small number of highly funded “high performance universities”. Indeed, more fundamental reform appears necessary to increase the capacity of the education system to produce high-quality output.

27. In this context, it is important to note that the performance of the tertiary education system is to a certain degree conditional on the performance of pre-tertiary education. Germany’s low scoring in the PISA exercise suggests that improving the effectiveness of secondary education could make a substantial contribution to raising the efficiency of tertiary education.⁶¹ Moreover, the organisation of students’ access to universities is likely to be partly responsible for the low rates of students in tertiary education. The share of students being formally eligible for university access within the relevant age cohorts is low in Germany by international comparison. As a rule, eligibility to university access is confined to students with a higher non-vocational degree (*Abitur* or equivalent). Vocationally-oriented degrees in secondary education mostly do not qualify for university access, and where they do few students chose this track to access a university. Those who are eligible for tertiary education can in principle freely choose their tertiary institution. If the students’ demand exceeds the number of places offered, by university and by study, students are allocated to universities by a federal administration, the selection criterion being the students’ grades in secondary education and their waiting time. The government has drafted legislation to allow universities to choose up to 60 per cent of their students in courses in which entry is restricted. This would be a welcome step, as the system of university access is likely to be one factor preventing the potential among young people for

61. See OECD (2001c). Also: OECD (2002).

tertiary education from being fully exhausted, and may produce an inefficient match between universities and students. Efforts should be made to insure that non-academic tracks of secondary education prepare better for direct entry to university education, so as to reduce the formal divide between vocational and non-vocational degrees. Moreover, the bureaucratic allocation of students to universities should be given up entirely to give universities further discretion to choose students.

28. The German tertiary education system relies heavily on government funding, which accounts for more than 90 per cent of total finance. This is somewhat below the European average, while in non-European member countries of the OECD funding from non-governmental sources covers between more than 30 per cent (Canada) and more than 70 per cent (Korea) of total outlays. The operating costs of universities are largely financed out of the *Länder* budgets while the federal government and the states cofinance investment. Most of university funding reflects the regional development of capacities as agreed between the federal government and the states, with the notable exception of special research projects, where public sector funding is based on evaluations of independent scientists. As debt of the federal and the state governments is mounting, finances of tertiary education institutions is increasingly coming under pressure, with some governments cutting back their funding. Simultaneously Germany is aiming to increase its cohort-specific graduation rate by 10 percentage points over the next years, which is further increasing the pressure on the general government budget. Moreover, additional funding will be required to implement the plans of the federal government to promote high-performance universities.

29. All of these pressures reinforce the need to improve the allocative efficiency of funding tertiary education. In recent years first steps have been made in this direction. The *Länder* are implementing models of performance-oriented allocation to varying degrees. In some federal states budgetary allocations are associated with the number of graduates rather than the number of students. This provides incentives to shorten study times and reduce the frequency of studies without a degree. However, the *Länder* are allowing at most 8 per cent of university funding to be determined in this way. While some *Länder* link substantially larger proportions of university funding to indicators, these are mostly input-oriented (such as the number of teaching staff) or demand-oriented (such as the number of students), resulting in weaker performance incentives.⁶² Much more is thus required. Reforms should quickly move on implementing a higher degree of competition among universities, with the allocation of public sector funding more strongly linked to performance indicators. Several countries within the OECD have moved in this direction, Austria being a recent example. Moreover, more use should be made of non-government funding. Indeed, within the OECD the level of funds spent for tertiary education tends to be higher the more countries rely on other sources of financing apart from government spending, notably student fees and grants.⁶³ In Germany tuition fees are virtually absent and, apart from special cases, prohibited by federal legislation. Putting in place a framework that allowed universities to levy tuition fees, complete with an income contingent loan-employment scheme, would seem to be a useful step. This would enable students to act as purchasers of the universities' services at the institution of their choice, providing a powerful incentive for universities to improve their services. Fees would also prevent students from considering tertiary education as a costless good, contributing to shorter and more efficient studies from the demand side as well. Income contingent credit schemes were recently introduced in the United Kingdom and are applied for more than a decade in Australia and New Zealand.⁶⁴ In Australia, fees had little impact on the socio-economic mix of students, while in New Zealand the share of ethnic minorities more than doubled since the beginning of the 1990s and participation in tertiary education almost doubled since the introduction of student fees in 1992. This

⁶² Leszczensky and Orr (2004)

⁶³ See OECD (2004).

⁶⁴ See OECD (2004).

suggests that, so long as tuition fees were strongly additional to present funds, and not a substitute, they would be accepted.⁶⁵

30. To make competition between universities viable, they should be given more autonomy with respect to the use of funds and personnel management to improve the quality of their services. Regulatory reform in this field would also improve incentives for non-governmental funding. At present, personnel are subject to tight employment regulations that restrain the scope of universities to attract highly qualified personnel and pose disincentives for employees to engage in high-quality teaching and research. Professors (including the recently introduced junior professor) have the status of tenured civil servants, salaried by the Land. Life time tenure is granted by the state government, with virtually no possibility of the universities to condition tenure on performance. While recent legislation allows for performance related components of pay for professors, this is not true for junior professorships and other research or teaching personnel. In the same vein, universities have little scope to attract highly qualified personnel via pay differentiation.⁶⁶ Also, professors are subject to certain teaching obligations that are fixed by state regulation. This makes contractual arrangements between the universities and its academic personnel about the relative weight of teaching and research more cumbersome.

...and the qualification level of net immigration needs to be improved

31. There is some evidence that Germany, like other European countries, is experiencing some outflow of highly qualified labour, in particular to the United States.⁶⁷ The number of German science and engineering employees working in the US increased by about 10 per cent (25 000) between 1995 and 1999 and appears large in comparison to the other larger non-English speaking EU countries. Regarding inflow from abroad, in recent years a steep increase was recorded in the number of foreigners studying information technology at German universities.⁶⁸ While the influx signals that German tertiary education in this field is internationally attractive, it is also likely to reflect that studying in Germany is effectively subsidised by the absence of student fees. More generally, over the last three years a limited number of work permits were granted to ICT professionals. Overall, however, migration to Germany appears significantly biased toward low qualifications. Since the hiring freeze of manufacturing “guest workers” in 1973, immigration is driven by family reunification of former guest workers who settled in Germany, asylum seekers, refugees from civil wars and ethnic Germans from eastern Europe. On average, immigrants have a significantly lower qualification than the domestic population.⁶⁹

65. See Lundsgaard and Turner (2004) on the introduction of study fees in the UK. According to a recent survey by the Forsa institute, commissioned by Stifterverband für die Deutsche Wissenschaft. According to the poll, 59 per cent of the students are in favour of paying a fee of € 500 per semester, provided both the funds are earmarked to their university so as to improve the quality of the university and there are loans available that only need to be redeemed after the end of studies if income exceeds a certain threshold. By contrast, 94 per cent of the students reject study fees if these are not earmarked, acting just as an additional source of revenues for the purpose of relieving the governments’ budgets. In the population at large 67 per cent are in favour of fees earmarked to the university and 72 per cent are against fees if they are not earmarked. In the same survey three years earlier a smaller share of 47 per cent of the students responded in favour of fees (quoted in *Handelsblatt*, 11th December 2003).

66. For example, the fact that university professors of German citizenship are civil servants, who are not liable to pay social charges, can pose a barrier to attract foreigners, who are subject to such charges.

67. See European Commission (2003).

68. See Engeln *et al.* (2003).

69. See for example: Constant and Massey (2002) Constant and Shachmurove (2003). At its peak in 2001 immigration to Germany totaled 879 200 persons and emigration out of Germany 606 500 persons. For

32. Most of the regulatory features concerning product, labour and capital markets discussed above can also influence the location decision of high-qualified labour and of enterprises. Progress on these scores therefore also improves Germany's position in the international competition for knowledge and capital. Moreover, the size of wage *premia* for skills are a potentially important determinant of a location's attractiveness for the high-qualified. If wage *premia* for qualification are relatively small, incentives to emigrate increase with the level of qualification. The distribution of gross wages in Germany appears to be more compressed than in some other countries, notably the United States, limiting the extension at the upper tail of the distribution. Empirical evidence suggests that compression derives to a certain degree from relatively high skill levels among German workers in the lower part of the wage distribution. However, there are other factors that compress the German wage distribution from below while hampering it to spread out to higher pay.

33. Germany's relatively high taxation of high incomes makes it costly for enterprises to provide high take-home pay in favour of the high-qualified. According to a study comparing six EU countries, Switzerland and the US Germany belonged to the countries with the highest average effective taxation of wages for high-qualified personnel before the income tax reductions in 2004 and 2005 (see **Figure 2** above).⁷⁰ This position is set to improve, however, once the reductions have been fully phased in. Moreover, the rigid pay schemes for public sector employees in research institutions and universities restrain the scope for competitive remuneration in these large segments of the German research sector. In line with these findings, empirical research suggests that the pre-tax wage *premia* associated with an extra year spent in education is significantly lower in Germany than in the United States.⁷¹

34. In sum, these findings reinforce the need for fiscal reform that reduces the taxation of labour, including the high-qualified, and reform in the social transfer system and labour relations reducing effective minimum wages at the low end of the pay scale. Reforming the funding of universities is also necessary, as outlined above. New immigration legislation that aims at introducing qualification standards for immigrants seeking dependent and self-employment in Germany has been decided. Legislation along this line that raises the qualification profile of immigrants would probably yield significant benefits.

Government support can be effective but requires a favourable regulatory environment

35. Externalities from innovation can be substantial, justifying some government support for innovation activities.⁷² Government intervention is most necessary where markets completely fail to provide research which is beneficial to society. This is most apparent in basic research, which as a result of its public goods characteristics, is not provided through the market, and in Germany is conducted in public sector research institutions (see **Box 2** above). In the business sector, positive externalities come about, *inter alia*, because innovators cannot appropriate the full return of their effort, given that protection of intellectual property rights is limited. All OECD countries, including Germany, provide subsidies to enterprises for innovation in terms of transfers or tax advantages for R&D spending. In Germany government support for innovation in the business sector for civilian purposes is below the levels in Japan, the UK and France but above those in Finland and the US.⁷³ Innovation is subsidised entirely through transfers. The following issues warrant particular attention:

international comparisons of educational attainments of foreign and national populations see OECD (2003e).

70. Elschner *et al.* (2003).

71. See Psacharopoulos and Patrinos (2002).

72. See Griliches (2001) and Jones (1998).

73. Rammer *et al.* (2004).

- As is the case with other subsidies, support for innovations need to be carefully designed to limit distortion and assure effectiveness. While evaluations of some German programmes indicate that support has raised R&D spending of participating firms over and above the received amount of public support,⁷⁴ not all programmes have been subjected to evaluation. Hence, evaluation needs to be stepped up.
- The subsidy programmes appear to be complex in comparison to other countries.⁷⁵ Relatively high administrative costs for both the programmes' administrators as well as the enterprises are likely to hamper participation of small and medium sized enterprises and favour "insiders" -- firms that are already familiar with the programmes. The latter may contribute to the finding that government-supported business R&D spending is more concentrated on large firms than total business R&D spending,⁷⁶ notwithstanding recent increases in the number of enterprises picking up government support. Programmes should therefore be simplified. In the same vein, the general nature of externalities suggests that criteria for participation in R&D support programmes should be widened. However, safeguards -- thorough ex ante assessment and ex post evaluation -- need to be in place to limit rent-seeking.

Special support conditions for the new Länder should be reduced

36. Considerable public sector resources were devoted over the last decade or so to support R&D in the new states. With enterprises in the east hardly meeting the same set of eligibility conditions for financial aid that applied to enterprises in the west, the policy response was to design various special subsidy programmes that broadened the coverage of aid in the east. . This policy has contributed to widening the share of research intensive sectors in the economy. However, some indicators suggest that scope to increase the efficiency of policies affecting innovation might be significant. While the share of companies with continuous R&D activity is higher in the east than in the west the opposite is true for the contribution of research-intensive sectors to value added. Also, the return from innovation relative to its costs is substantially lower than in the west. This is mainly true for process innovation while the difference is only modest for product innovation.⁷⁷

37. Various structural factors are likely to account for the relatively weak return to R&D in the new states. Much is attributable to the fact that in comparison to the old states the size distribution of firms is heavily skewed toward smaller enterprises.⁷⁸ This reduces the share of innovation associated with large firms whose innovative potential is normally high, notably in terms of internal financing capacity, potential spin-offs of new innovative firms and demand for intermediate inputs from other business. Regarding smaller enterprises, however, firm entry has been declining for several years and enterprise growth is relatively weak, both weighing on innovation. In the same vein, endowment with equity capital -- as a share of the firms' balance sheets -- is significantly smaller in eastern German enterprises than in western ones, reducing the capacity to engage in risky innovation activities. Relatively high wage settlements in eastern Germany can reinforce this weakness by putting profit margins under pressure. Indeed, empirical

74. Czarnitzki *et al.* (2002), Czarnitzki and Fier (2003).

75. Rammer *et al.* (2004).

76. While enterprises with fewer than 250 employers received 7.3 percent of government-financed R&D, they conducted 9.3 percent of all business R&D. OECD (2003b).

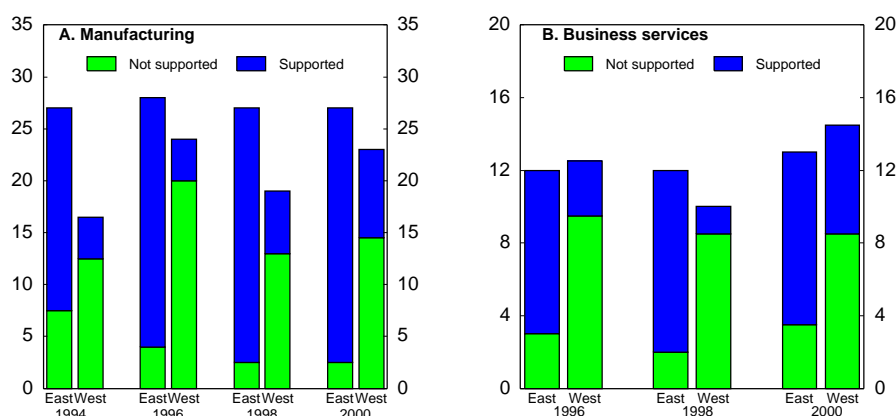
77. See Deutsches Institut für Wirtschaftsforschung, (2003).

78. See Rammer and Czarnitzki (2003).

evidence for the new states, as well as for Germany overall, suggests that firms respond to wage increases that exceed underlying labour productivity growth by scaling back investment.⁷⁹

38. Also, to some extent, subsidisation is likely to have supported R&D activity in areas with low returns. Indeed, in eastern Germany some 90 per cent of manufacturing enterprises with continuous R&D activity receive financial aid from the public sector, as opposed to thirty per cent in the west (**Figure 7**). While surveys indicate that only one third of supported firms would be active in R&D without support, generous special aid raises incentives for rent seeking, associated with the risk that an artificially high share of innovation activities might not stand the market test in later years.

Figure 7. Share of enterprises with continuous R&D
Per cent



Source: Zentrum für Europäische Wirtschaftsforschung (ZEW)

39. Hence, especially for the new states, reforming economic framework conditions in capital, product and labour markets and in the education system is necessary to raise the effectiveness of government support for innovation. Without such reform, support programmes are bound to remain of limited effectiveness, implying undue fiscal burdens for the general government. Moreover, there is a risk that continuing generous special support programmes for enterprises in the new states perpetuates inefficient economic structures.⁸⁰ Therefore, special support conditions should be reduced.

Summary

40. Germany belongs to the countries with strong innovation activity in the OECD, although innovation effort may have weakened somewhat in recent years. While productivity growth in Germany has slowed, there is scope to improve economic framework conditions in a number of areas so as to enhance the economy's capacity to innovate and reap the full benefits of innovation for raising productivity and employment. Reducing administrative opacity would support the creation of new enterprises, which are particularly important in developing and adopting new technologies. Simplification of Germany's complex income tax code is important in this respect. Also, various features of the tax system hamper the

79. For an investigation, based on firm-level data, of the impact of wage setting on productivity and investment in eastern Germany see: Lehmann (2003). For an empirical investigation of the impact of wagesetting on investment for Germany overall, based on aggregate data, see Weyerstrass and Klaus (2003).

80. High rates of subsidisation in the 1990s, notably for capital intensive production and construction, have biased the structure in the eastern economy. See OECD (2001a). For more detail see also Wurzel (2001).

development of risk capital markets, calling for reform. A positive impact on innovation activities, in particular in fields that are associated with rapid technological change, can be expected from policy action that supports the capacity of the labour market to reallocate labour. In the same vein, provisions need to be made to secure the availability of a well trained and highly qualified workforce in the future. This reinforces the need to improve the efficiency and the access to the tertiary education system and to adopt measures that raise the qualification profile of immigrants. Finally, government aid programmes to enterprises in favour of innovation should be more subjected to evaluation. At the same time, support programmes should be simplified, while special subsidies for the new states should be reduced.

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