

# Prospect of the German Economy

## Innovation Activities in Manufacturing and Mining

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Survey 1999

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# Innovation Activities in the German Economy

## Manufacturing and Mining: Survey 1999

■ Innovation activities in German manufacturing and mining have further increased in 1998. With 66%, the share of innovative companies reached its highest level of the past years. Almost 41 thousand companies renewed their products or production processes, 39 thousand of which are small and medium-sized enterprises (SMEs) with less than 500 employees.

Compared to last year, total innovation expenditure rose by an additional 6 billion DM to currently 109 billion DM. Particularly capital innovation expenditure experienced a distinct increase. 44 billion DM were spent on innovation investments.

Innovation activities of companies could be considerably increased, if they were not hampered by different factors. In the past few years, lack of qualified personnel has become one of the most serious factors hampering innovation. 16% of the companies in manufacturing and mining, i.e. more than 10 thousand companies, were significantly hampered in their innovation activities, because they lacked adequately qualified personnel.

However, the companies are to some extent also responsible for this situation. Companies complaining about lack of adequately qualified personnel, do not try to compensate this shortage by engaging all the more in further training activities.

For this reason, both educational policy and companies face the challenge to support innovation politics with medium and long-term measures, and to provide adequately qualified personnel.

Innovation endeavours which were carried out on a broad front, did not lead to the corresponding result in all sectors of the economy. Particularly the innovation success of SMEs still lags behind the large enterprises. In 1998, SMEs generated approximately 30% of their turnover with product innovations. That is one quarter less than the average of all size classes.

Innovation activities in the new Länder (federal states in the East of Germany) have largely adapted to the West German ones. Only the turnover share (3<sup>1</sup>/<sub>2</sub>%) due to market novelties is a good 1<sup>1</sup>/<sub>2</sub> points below the value of Germany as a whole.

### Indicators on Innovations in 1998

Share (in%) of firms with	Share 1998	Changes compared to	
		1997	1994
Innovations	66	3	17
Product Innovations	62	2	16
Process Innovations	54	5	15
Market Novelties	28	5	6
Cost reduction	39	1	14
	Share 1998	Changes compared to	
		1997	1996
Share of Turnover due	39,5		

Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.

Comment: Shares in Percent, Changes in Percentage Points. Values preliminary. All information projected to the frame population in Germany.

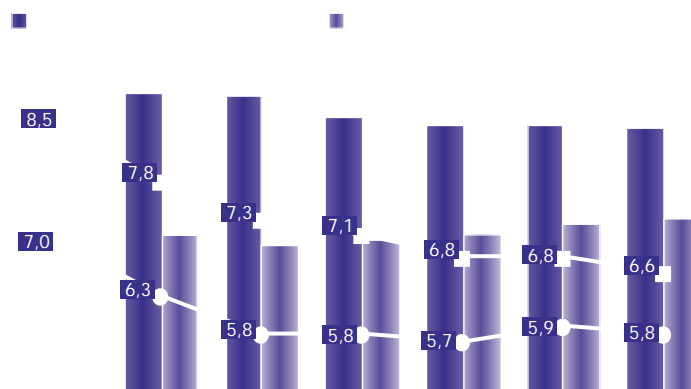
A market-oriented targeting or enlargement of state innovation policy, i.e. direct innovation support and market orientation of direct assistance, measures can contribute to a stronger market focus of the innovation endeavours of the enterprises in manufacturing and mining.

### Development and Structure of Innovation Activities

Innovation activities in manufacturing and mining continue to follow the clear

trend of further increases. In 1998, the share of innovative companies attained nearly 66%, i.e. two thirds, and rose once again by 3% points, compared to last year. Not only the share but also the absolute figure of innovators has been steadily increasing since 1994 to today's value of almost 41 thousand companies.

In contrast, the total number of companies in manufacturing and mining declined during the 90ies and began to stabilise only at the end of the decade. The number of companies diminished compared to



1994 by 12% to 62 thousand companies. Apparently, innovative companies are able to compete more easily on international markets.

The renewed increase of the share of innovators is mainly attributable to an increase of process innovations, which rose in 1998 by 5% points to 54%. The innovation portfolio clearly shifted in the direction of production processes.

The share of product innovators rose only slightly to 62%, which is a very high level even in the international comparison. This means that 38 thousand companies in manufacturing and mining modernised or expanded their product range within the past three years, and that 34 thousand companies improved their production processes.

The number of employees in innovative companies of the manufacturing and mining have experienced a stable development since 1994 and fluctuates around a value of about 5.8 million DM. In 1998, this corresponded to approximately 88% of the 6.6 million people working in these economic sectors. In the whole sector, however, the number of employees diminished by 22% in the course of the 90ies. In 1992, approximately 8.5 million people were still gainfully employed in this sector.

### Product and Process Innovations

Innovators are companies which have successfully implemented at least one innovation project within the last three years, i.e. they implemented at least one innovation. It does not matter, whether another company already introduced this innovation on the market. What counts is the evaluation out of the company's viewpoint.

Innovations can be implemented either as product or process innovations. Product innovations are new or significantly improved products which a company has introduced on the market. Purely aesthetic modifications of products are not considered as product innovations. Process innovations are new or significantly improved production and process technologies, which are introduced in a company. New production processes sold to other companies are considered as product innovations.

The definitions and differentiations comply with those of the OECD and Eurostat, fixed in the so-called Oslo-Manual.

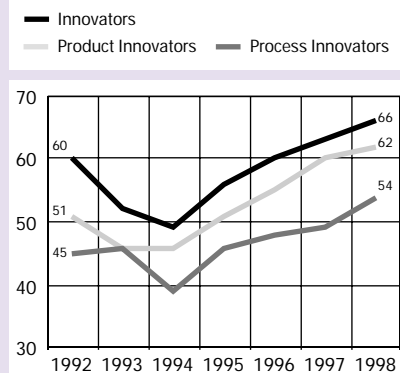
Contrary to popular opinion, process innovations are not necessarily linked with job cuts: the number of employees at process innovators has slightly increased since 1994, and amounted to about 5.4 million persons in gainful employment in 1998. In contrast, this value fluctuates around 5.5 million among the product innovators. For this reason, process innovations do not necessarily entail staff reductions in the form of rationalisation measures.

Industries which are traditionally research-intensive, i.e. industries with a high or very high R&D-intensity are extraordinarily innovative. In 1998, 83% of the enterprises in this sector counted among the innovators, about as many as last year. On the other hand, employment declined also in the R&D-intensive manufacturing branches by 4% to 2.7 million, compared to the previous year.

Even in the traditionally less research-oriented manufacturing branches, i.e. in branches with low R&D-intensity, the innovator share amounted to 61%. These sectors continue to account for almost 60%, i.e. 3.8 million jobs in manufacturing and mining. Employment remains more or less stable in these traditionally less R&D intensive branches, at most, a slight decline can be detected.

The differences in innovation inclination within manufacturing and mining becomes more apparent at the level of individual industrial branches. Electrical engineering and the chemical industry (in-

### Innovation Activities 1992 to 1998



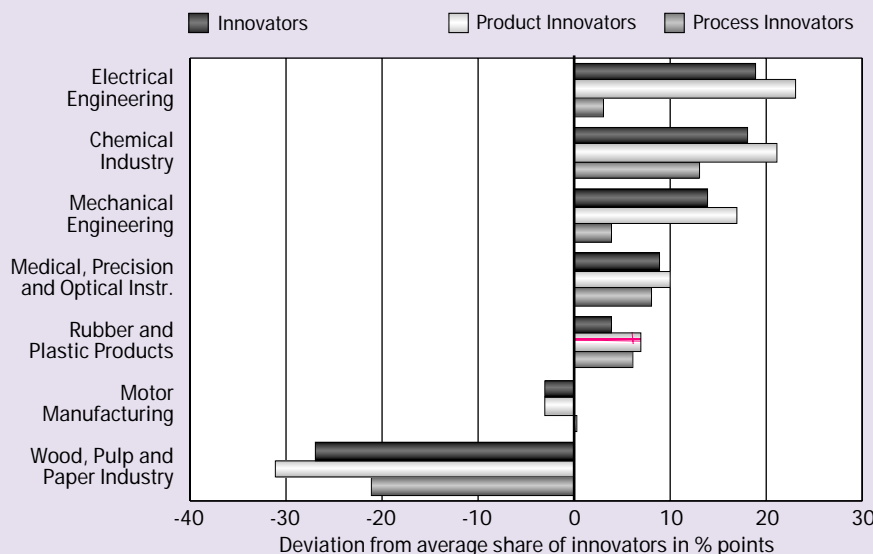
Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining. Comment: Values for 1998 preliminary. All information projected to the frame population in Germany.

cluding the pharmaceutical industry) are the most innovative industries. Far more than 80% of the companies in these industries implemented product or process innovations. Innovation inclination is also above average in mechanical engineering and manufacture of medical, precision and optical instruments. In contrast, innovation inclination is slightly below average in the textile industry. With 38%, the wood, pulp and paper industries account for the lowest share of innovators.

### Development and Structure of R&D-Activities

Traditionally, research and development activities constitute the core func-

### Innovation Activities in Selected Branches 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining. Comment: Values for 1998 preliminary. All information projected to the frame population in Germany.



## R&D Activities

Research and experimental development (R&D) comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge and to apply it to new problems. This includes the construction and testing of prototypes, the development of software (if this includes a significant improvement) and the acquisition of extramural R&D. This definition complies with the Oslo-Manual and thus also with the Frascati-Manual of the OECD.

tion of operational innovation activities. In the past years, however, R&D activities lost some of their importance, compared to other market-near innovation activities. While the share of innovative companies rose continuously in the past 3 years, the share of companies carrying out R&D declined in 1998 by nearly 5% points compared to 1996. Just under 60% of innovative companies in manufacturing and mining carried out R&D also in 1998.

Continuous R&D activities, for instance the establishment of a R&D department, acquired relatively more importance in the course of the 90ies. The majority of companies carrying out R&D meanwhile does so on a regular basis. Almost every third innovative company, approx. 20% of all enterprises is engaged in continuous R&D.

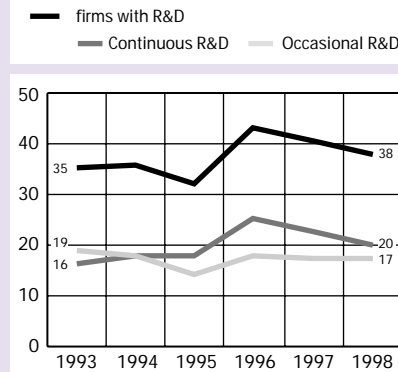
The chemical industry accounts for the highest share of companies engaged in

## R&D Intensity

Branches with high or very high research and development (R&D) intensity are branches (based on the three-digit NACE-code – WZ93 – of the Federal Statistical Office), for which the average share of R&D expenditure in turnover accounts for at least 3%. Amongst others, the pharmaceutical industry, telecommunications technology, the aerospace industries, as well as large parts of the chemical industry, electrical engineering, and motor manufacturing industry belong to these sectors.

Enterprises with low R&D intensity are firms in sectors whose average share of R&D expenditure accounts for less than 3% in turnover. The food & beverages, textile and leather, as well as metal industries belong to these sectors.

## R&D Activities 1993 to 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
Comment: Values for 1998 preliminary, not ascertained for 1997. All information projected to the frame population in Germany.

R&D. Meanwhile, more than two thirds of all chemical companies, i.e. about 69%, are performing R&D. Mechanical engineering (61%) as well as manufacture of medical, precision and optical instruments (58%) are also characterised by an extraordinarily high share of enterprises carrying out R&D. Companies in the timber and paper industry (14%) as well as in the food & beverages and tobacco industry (21%) are less R&D oriented.

The share of companies engaged in R&D is more than twice as high for companies with at least 500 employees, compared to the mean value of manufacturing and mining. More than 80% of large enterprises are engaged in R&D activities. They hence continue to make the largest contribution to the research and development of new products and processes.

## Development and Structure of Innovation Expenditure

Compared to last year, innovation expenditure of companies in manufacturing and mining rose again by 6 billion DM to currently 109 billion DM. The steady growth observed since 1994 therefore continues.

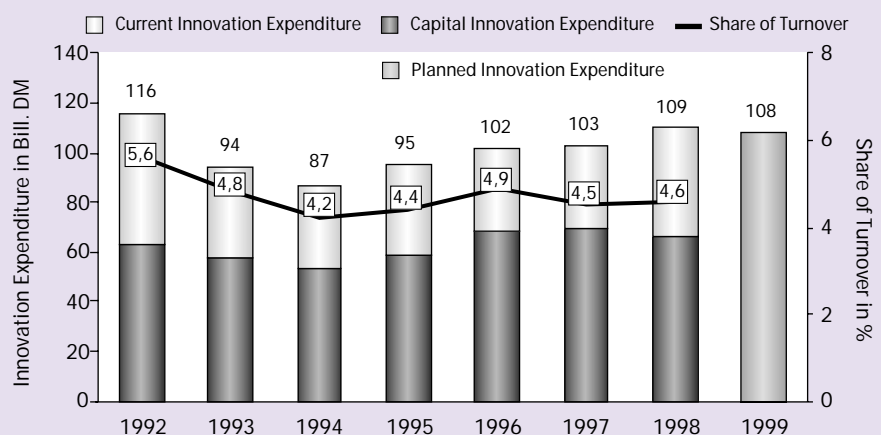
However, based on the projected figures for 1999 stated by the companies, a further increase of innovation expenditure cannot be expected. Particularly West German companies made very careful projections for 1999. Based on past experience, companies can either stay below or exceed the projected value they indicated.

Innovation intensity, measured as share of innovation expenditure in turnover dropped from almost 5% in 1996 to 4½%. The distinct increase of the German industry's turnover does not necessarily seem to give a further innovation incentive.

In the mid-nineties, principally current innovation expenditure determined the development of total innovation expenditure. However, the rise of innovation expenditure in 1998 resulted from a distinct increase of capital innovation expenditure. In 1998, the companies spent 44 billion DM for capital innovation expenditure, i.e. 40% of total expenditure. In 1997, this share was still as low as 33%.

The shift in shares from current to capital innovation expenditure is reflected in the disproportionate increase of the share of process innovations. Investments in production processes are usually linked with the acquisition of new machines and equipment.

## Innovation Expenditure 1992 to 1999



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
Comments: Values for 1998 preliminary. Values for 1999 are estimates/expectations of the firms. All information projected to the frame population in Germany.

Population, Sample, and Projection

The results of the ZEW innovation survey are stratifiedly projected to the stratified population of all enterprises with a minimum of 5 employees in manufacturing and mining in the Federal Republic of Germany in accordance with the differentiation in the NACE Classification of Economic Sectors (WZ93) of the Federal Statistical Bureau. Branches, company size (number of employees), and region (West and East Germany, that is: old and new Länder) serve as stratification characteristics.

Data on the population (company, employment, and turnover figures) until 1997 are based on publications of the Federal Statistical Bureau, and the ZEW's estimates on the number of small enterprises. Data from 1998 onwards are based on projections of the population and are thus preliminary.

The data bank of CREDITREFORM serves as a sampling frame. The sample of the year 1999 encompasses about 10,500 enterprises, 2,500 of which responded to the survey. This corresponds to a response rate of 24%. An additional 2,000 companies were randomly selected from the companies that did not fill in the questionnaire and were interviewed via telephone on core indicators of innovation behaviour, so as to correct any potential bias in the response behaviour of the companies.

The ZEW commissioned infas (Institute for Applied Social Sciences) with the management of the survey's field phase, which was conducted from March until August 1999.

In 1998, two thirds of innovation expenditure were carried out by large companies with 500 or more employees. This corresponds to almost 75 billion DM. Compared to last year, they nevertheless declined by almost 2 billion DM. The increased innovation expenditure are supported by small and medium-sized enterprises. In 1998, they spent about 35 billion DM on innovation projects, that is almost 30% more than in the previous year. From 1994 to 1997, innovation expenditure of large companies increased steadily, whereas it declined in small and medium-sized enterprises.

Particularly the traditionally less research-intensive industrial sectors reinforced their innovation activity through a distinct expenditure increase of 6 billion DM to 34 billion DM.

However, due to the large fluctuation of innovation expenditure in the past years, it remains to be seen whether this positive

development will continue. Companies in these industries already planned to cut their innovation budgets for 1999.

Enterprises from the traditionally research-oriented branches of industry, i.e. with high or very high average R&D-intensity, kept their innovation expenditure at last year's level of 76 billion DM.

Innovation Expenditure by R&D-Intensity of the Sector 1992 to 1999

Innovation Expenditure in Bill. DM

■ High and Very High R&D Intensity    ■ Low R&D Intensity

Turnover Shares due to Product Innovations

Turnover shares due to product innovations refer to the turnover of the respective year, which was generated with innovations within the past three years. The measurement of turnover shares was more broadly defined before 1996 and also included turnovers generated with improved, but not necessarily significantly improved products. The values reported before 1996 are therefore higher and cannot be easily compared with the values reported after 1996.

Source: ZEW (2000): Mannheim Innovation Panel Manufacturing and Mining.  
 Comments: Values for 1998 preliminary. Values for 1999 are estimates/expectations of the firms. All information projected to the frame population in Germany.

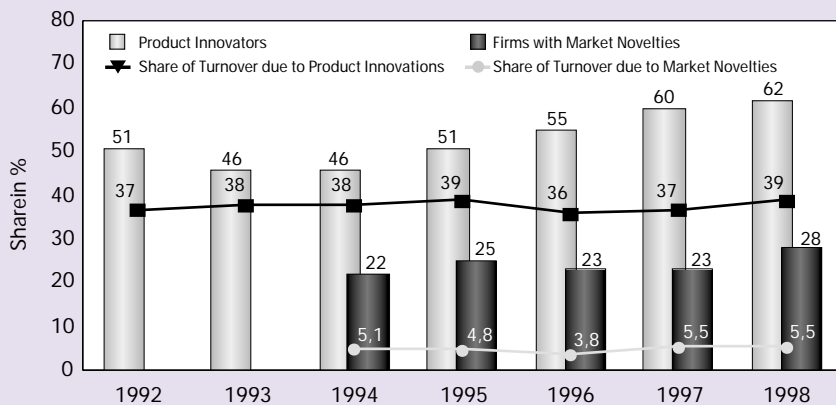
Reference Numbers of Innovation Activities in Manufacturing and Mining 1992 to 1998

	1992		1993		1994		1995		1996		1997		1998	
	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%
Firms (in Thsd.)	72	100	71	100	70	100	65	100	63	100	63	100	62	100
amongst those:														
Innovators	43	60	37	52	34	49	36	56	37	60	40	63	41	66
amongst those:														
Product Innovators	36	51	33	46	32	46	33	51	35	55	37	60	38	62
Process Innovators	32	45	32	46	27	39	30	46	30	48	31	49	34	54
Firms with R&D	-	-	25	35	25	36	21	32	27	43	-	-	23	38
under them:														
Continuous R&D	-	-	12	16	12	18	12	18	15	25	-	-	13	20
Occasional R&D	-	-	13	19	13	18	9	14	12	18	-	-	11	17
Employees (in Thsd.)	8.534	100	7.796	100	7.287	100	7.100	100	6.795	100	6.751	100	6.600	100
amongst those:														
Innovators	6.988	82	6.293	81	5.776	79	5.825	82	5.664	83	5.853	87	5.818	88
amongst those:														
Product Innovators	6.565	77	5.815	75	5.474	75	5.503	78	5.456	80	5.720	85	5.577	85
Process Innovators	6.021	71	5.746	74	5.118	70	5.185	73	5.053	74	5.386	80	5.355	81
Firms with R&D	-	-	5.503	71	5.156	71	4.991	70	5.280	78	-	-	4.745	72
under them:														
Continuous R&D	-	-	4.452	57	4.181	57	4.172	59	4.239	62	-	-	3.898	59
Occasional R&D	-	-	1.051	13	976	13	819	12	1.041	15	-	-	848	13
Innovation Expend. (in Bill. DM)	116	100	94	100	87	100	95	100	102	100	103	100	109	100
Share of Turnover in %	5,6		4,8		4,2		4,4		4,9		4,5		4,6	
under them:														
Current Innovation Expenditure	63	54	58	62	53	61	59	62	68	67	69	67	66	60
Capital Innovation Expenditure	53	46	36	38	34	39	36	38	34	33	34	33	44	40
Share of Firms with (Information in %)														
Market Novelties	-	-	-	-	22,0		24,7		22,6		23,4		28,5	
Cost Reduction	-	-	32,3		24,5		28,2		34,4		37,2		38,6	
Share of Turnover due to (Information in %)														
Market Novelties	-	-	-	-	5,1		4,8		3,8		5,5		5,5	
Product Novelties	37,0		38,2		38,0		38,7		36,0		37,0		39,5	
Share of Reduced Costs (Information in %)														
	-	-	7,1		4,1		4,4		6,2		7,1		6,1	

Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.

Comments: "-": Values not ascertained for that year. Values for 1998 preliminary. Turnover share due to product innovations for 1996 and 1998 only to a limited extent comparable to previous years. All information projected to the frame population in Germany.

Product Innovations 1992 to 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comments: Values for 1998 preliminary. Turnover share due to product innovation for 1996 and 1997 only to a limited extent comparable to previous years. Market novelties prior to 1994 not ascertained. All information projected to the frame population in Germany.

from 23% to 28%. There is thus a larger share of fundamentally new products among product innovations than in the previous years.

However, the market success of these innovations cannot keep up with this satisfying development. In contrast to the turnover shares due to product innovations, no clear growth trend can be determin-

Market novelties

Market novelties are new or significantly improved products, for which a company is the first provider and introduces them on the market. The enterprises define which market is relevant to them. Data on market novelties were not gathered before 1994.

Turnover shares due to market innovations refer to the turnover of the respective year, due to market novelties of the past three years.

ed for the turnover share due to market novelties, even though it rose, compared with 1996, by a good 1½ % points to as much as 5½ %. In comparison with the previous year, however, this share remained the same. At the end of the 90ies, on average, approximately every twentieth DM of turnover was generated through market novelties. Therefore, merely one seventh of turnovers generated through product innovations resulted from genuine market novelties, even though one out of three product innovators also introduced market novelties.

Cost reducing process innovations can be interpreted as the share of process innovations which are implemented for rationalisation purposes. The enterprises reported that in the 90ies approx. two thirds of process innovations were accompanied by cost reductions. However, around the end of the 90ies the relative importance of the rationalisation motive increased. In

Shares of Reduced Costs due to Process Innovations

Cost-reducing process innovations refer to process innovations that led to a reduction of average costs, and therefore tend to be based on a rationalisation motive.

Shares of reduced costs refer to costs of the previous year, which were reduced due to cost reducing innovations of the past three years.

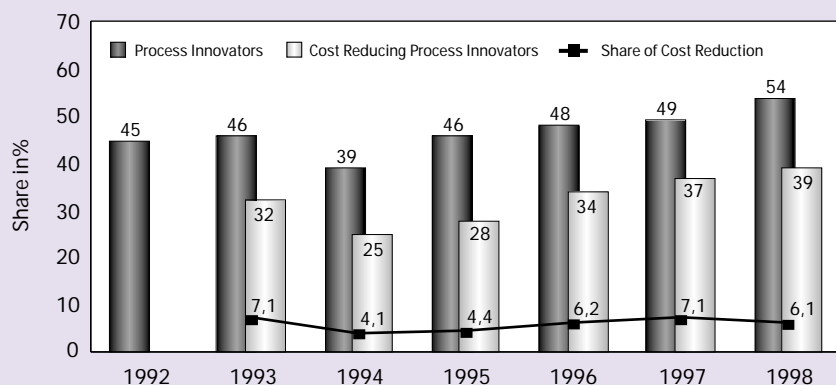
1997, more than three quarters of the process innovators – i.e. around 37% of all companies – stated that their innovations led to cost reductions.

This development, however, slowed down in 1998: cost reducing process innovations did not increase to the same extent as other process innovations. While the share of process innovators in all companies rose by about 5% points to 54%, the share of cost-reducing innovations increased only by about 2% points to 39%. A large share of process innovations was implemented together with product innovations without an identifiable direct rationalisation motive.

Efficiency of process innovations carried out for cost reduction purposes can be measured as cost reduction share in overall costs. In the mid-nineties, companies were thus able to save around 4% to 7% of production costs per year. After a steady increase from 1994 to 1997, this share decreased slightly versus the value of the previous year. In 1998, the enterprises were able to save more than 6% of their costs.

Companies in branches with a high or very high average research intensity were principally responsible for the overall decline of the cost reduction share. Here, the value fell by more than 2% points from almost 10% to about 7½ %. Due to the short time series and relatively large fluctuations, it is not possible to deduct any specific tendencies.

Process Innovations 1992 to 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comments: Values for 1998 preliminary. Cost reductions for 1992 not ascertained. All information projected to the frame population in Germany.

Innovation Activities of Small and Medium-Sized Enterprises

Small and medium-sized enterprises (SMEs) constitute the majority in manufacturing and mining. The share of SMEs in the total number of companies remained constant at around 97%. In 1998, this corresponded to slightly more than 60 thousand enterprises. Since 1996, not only the

## SMEs

Small and medium-sized enterprises (SMEs) are enterprises with at least 5 and less than 500 employees.

Because of their relatively large number, small and medium-sized enterprises dominate all shares relating to company figures. On the other hand, large enterprises dominate all shares which refer to DM amounts, due to their large financial volumes. Employment figures depend on both of these groups.

number of companies, but also the number of employees has stabilised to a large extent among SMEs. In 1998, approx. 3.3 million people were employed in small and medium-sized enterprises in manufacturing and mining. That is distinctly more than half of all the employees working in these sectors.

The development of innovator shares corresponds to a large extent to the overall evolution in manufacturing and mining. In 1998, the share of innovative companies rose from 62% to 65%, compared to the value of the previous year. A total of 39 thousand SMEs introduced new or significantly improved products or processes.

The share of product innovators rose slightly, in parallel with the whole sector, by 2% points to the high level of meanwhile 61%. The share of SMEs that innovated production processes, increased considerably by a good 5% points to 53%. The growing relative importance of process innovations, measured on the basis of the respective share of companies also emerges among the SMEs, because they dominate the variables of the whole sector which refer to the number of firms.

The increased relative importance of process innovations influences the development of innovation expenditure. Compared to the previous year, they rose sharply by almost 30% in 1998, and now amount to 35 billion DM. The rise in innovation expenditure in the whole of manufacturing and mining, can be traced back exclusively to increased expenses on the part of the SMEs, which by far compensated the slight decline of innovation expenditure among large enterprises.

Correspondingly, innovation expenditure of SMEs rose not only in absolute terms, but also in relation to turnover, contrary to the whole sector. Innovation intensity increased to 4% and hence approached the ratio of large enterprises.

However, this increase is not likely to continue. Rather, the companies' planned figures for 1999 leads to expect a slight reduction of expenditure. The planned innovation budget of 32 billion DM is, however, still clearly above the value of 1997.

Turnover shares that SMEs attained with product innovations are still distinctly below the values of large enterprises, and are, on average, slightly lower than in manufacturing and mining as a whole. In 1998, 30% of the turnover was generated with new or significantly improved products. The increase is slightly higher among SMEs in the traditionally less research-intensive industries. Their turnover share due to product innovations amounted to approximately 26% in 1998, compared to 23% in the previous year.

The share of SMEs with market novelties rose significantly to 27% in 1998. This corresponds to a growth of 5% points compared to last year. They thus exceeded the share of the large enterprises for the

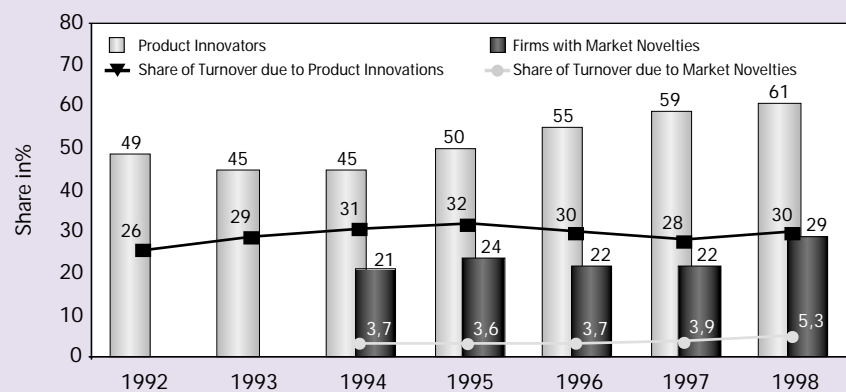
first time: SMEs, too, are genuine innovators and not only imitators.

SMEs were able to increase their turnover share due to market novelties to more than 5% and hence approached the quota of the large enterprises. Since 1995, the SMEs' success with market novelties has steadily increased. With a turnover share due to market novelties of about 8%, SMEs in the capital goods industry have the highest success rate.

The share of enterprises among SMEs with cost-reducing process innovations developed analogously with manufacturing and mining as a whole. At the end of the nineties, rationalisation innovations acquired more importance in relative terms. However, the increase of process innovations for rationalisation purposes was decisively more moderate in 1998 than in the previous year.

The share of cost savings attained through these innovations stagnated at 4% in 1998, and hence corresponds more

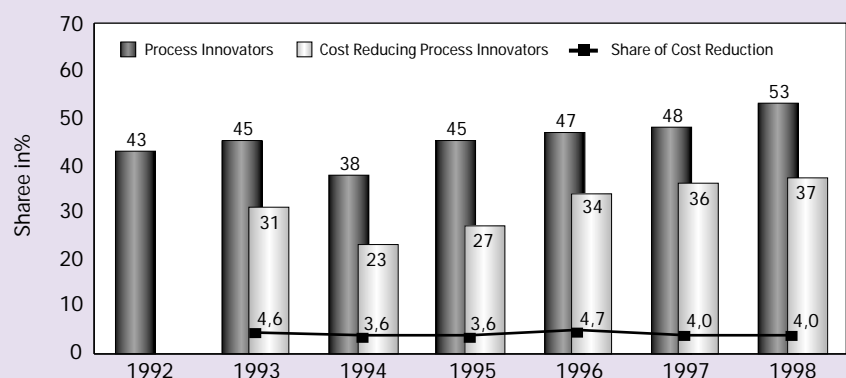
### Product Innovations of SMEs 1992 to 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.

Comment: Values for 1998 preliminary. Turnover share due to product innovation for 1997 and 1998 only to a limited extent comparable to previous year. Market novelties not ascertained prior to 1994. All information projected to the frame population of SMEs in Germany.

### Process Innovations of SMEs 1992 to 1998

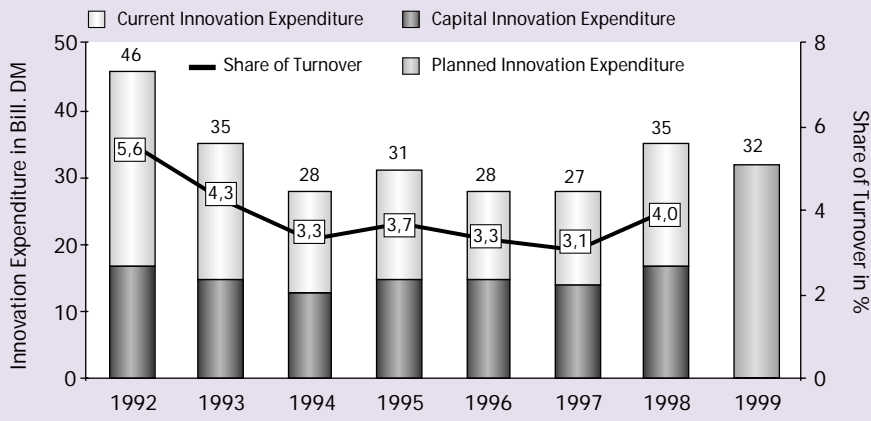


Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.

Comment: Values for 1998 preliminary. Cost reductions not ascertained prior to 1993. All information projected to the frame population in Germany.



Innovation Expenditure of SMEs 1992 to 1999



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comment: Values for 1998 preliminary. Values for 1999 are estimates/expectations of the firms. All information projected to the frame population of SMEs in Germany.

or less to the mean value of the past years. This share is, however, significantly lower than that of large enterprises, which realise a much higher rationalisation volume.

Innovation Activities in the New Länder

Since the beginning of the 90ies, the number of companies in manufacturing and mining in the new Länder has increased by about a third to almost 9 thousand in 1998. This corresponds to approximately 14% of the industrial enterprises in Germany as a whole. At the beginning of the 90ies, the share was still distinctly below 10%.

Employment development, however, was not able to keep up with this change. On the contrary: since 1992, the number of jobs in East German manufacturing and mining declined from about 840 thousand by almost 35% to little more than 550 thousand. By the end of the 90ies, however, the decline in employment was

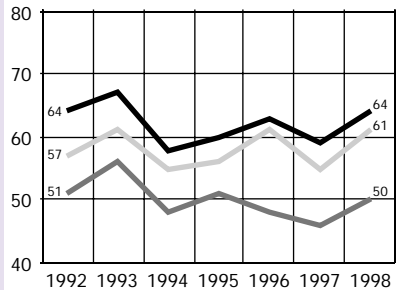
not only slowed down, but nearly brought to a standstill. From 1996 to 1997, even a slight increase was registered, which unfortunately did not continue in 1998.

In the light of the continuing unstable economic development, innovation activities in the new Länder are still subject to quite large fluctuations. Nevertheless, the share of innovative companies in East Germany always exceeded the West German comparative value until 1996. However, the catching-up process that was reflected in these values, failed to be detected in the innovator share since 1997, even though it increased again considerably by 5% points to 64% in 1998, after a slight setback in the previous year. East German companies indeed adopted their innovation behaviour in many respects to that of their West German competitors.

The share of companies that modernised or expanded their product range is

Innovation Activities in the New Länder 1992 to 1998

Innovators, thereunder:  
 Product Innovators  
 Process Innovators



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comment: Values for 1998 preliminary. All information projected to the frame population in the New Länder in Germany.

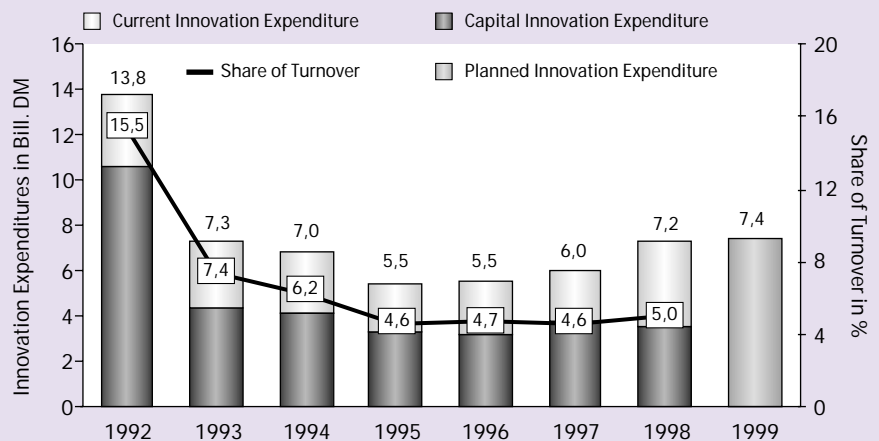
more or less the same in both regions of Germany. However, the share of process innovators in the new Länder experienced a more moderate increase than in the old Länder. In view of the fact that the new Länder's productivity development is still lagging behind, the question arises whether the production plants are already sufficiently modernised.

Also, employment structure still differs considerably in both parts of Germany. Despite the nearly identical innovator share, the employee share of innovative companies (81%) is still far below the national average of 88%. Even though the share increased by 5% points in comparison to the previous year, relatively many people continue to work in non-innovative companies in the new Länder.

New Länder

In the survey, companies in the new Länder include firms from the federal states in East Germany as well as firms in former West Berlin. Due to the relatively small amount of cases, statements on large enterprises (500 employees, or more) and individual sectors rest on a weak foundation. In addition, company, employee, and turnover figures are still subject to relatively large fluctuations over time, which makes it difficult to identify general tendencies.

Innovation Expenditure in the New Länder 1992 to 1999



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comments: Values for 1998 preliminary. Values for 1999 are estimations/expectations of the firms. All information projected to the frame population in the new Länder in Germany.

## Reference Numbers of Innovations Activities in Manufacturing and Mining – Small and Medium Sized Firms 1992 to 1998

	1992		1993		1994		1995		1996		1997		1998	
	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%
Firms (in Thsd.) amongst those: Innovators	70	100	68	100	68	100	63	100	61	100	61	100	60	100
amongst those: Product Innovators	41	59	35	51	33	48	34	55	36	59	38	62	39	65
Process Innovators	34	49	31	45	31	45	31	50	33	55	36	59	36	61
Firms with R&D under them: Continuous R&D	30	43	31	45	26	38	28	45	28	47	29	48	32	53
Occasional R&D	–	–	23	34	24	35	19	31	25	42	–	–	22	36
Employees (in Thsd.) amongst those: Innovatoren	3.823	100	3.637	100	3.565	100	3.423	100	3.330	100	3.375	100	3.346	100
amongst those: Product Innovators	2.597	68	2.462	68	2.367	66	2.481	72	2.541	76	2.624	78	2.674	80
Process Innovators	2.261	59	2.176	60	2.241	63	2.273	66	2.358	71	2.516	75	2.533	76
Firms with R&D under them: Continuous R&D	1.922	50	2.119	58	1.978	55	2.051	60	2.103	63	2.229	66	2.303	69
Occasional R&D	–	–	1.852	51	1.903	53	1.744	51	2.165	65	–	–	1.820	54
Innovations Expend. (in Bill. DM)	46	100	35	100	28	100	31	100	28	100	27	100	35	100
Share of Turnover in % under them: Current Innovation Expenditure	17	37	15	44	13	47	15	47	15	53	14	50	17	48
Capital Innovation Expenditure	29	63	20	56	15	53	16	53	13	47	14	50	18	52
Share of Firms with (Information in %)														
Market Novelties	–	–	–	–	21,1	3,3	23,7	3,7	21,5	22,2	22,2	3,1	27,3	4,0
Cost Reduction	–	–	31,2	4,6	23,4	3,6	27,2	3,6	33,6	35,9	35,9	4,0	37,4	4,0
Share of Turnover due to (Information in %)														
Market Novelties	–	–	–	–	3,7	3,7	3,6	3,6	3,7	3,9	3,9	3,9	5,3	5,3
Product Novelties	26,1	26,1	28,9	28,9	30,9	30,9	32,3	30,3	30,3	28,0	28,0	28,0	30,5	30,5
Share of Reduced Costs (Information in %)	–	–	4,6	4,6	3,6	3,6	3,6	3,6	4,7	4,0	4,0	4,0	4,0	4,0

Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.

Comments: "–": Values not ascertained for that year. Values for 1998 preliminary. Turnover share due to product innovations for 1996 and 1998 only to a limited extent comparable to previous years. All information projected to the frame population of SMEs in Germany.

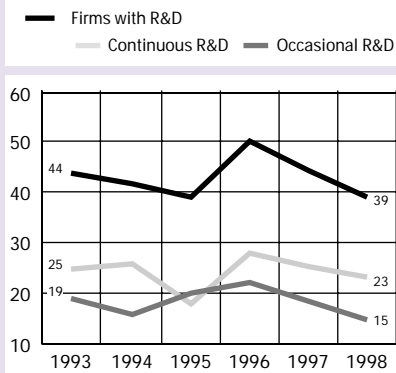
## Reference Numbers of Innovations Activities in Manufacturing and Mining – New Länder 1992 to 1998

	1992		1993		1994		1995		1996		1997		1998	
	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%	absolute	in%
Firms (in Thsd.) amongst those: Innovators	6,8	100	7,7	100	8,5	100	7,9	100	7,9	100	8,4	100	8,8	100
amongst those: Product Innovators	4,3	64	5,2	67	4,9	58	4,8	60	5,0	63	4,9	59	5,6	64
Process Innovators	3,9	57	4,7	61	4,7	55	4,4	56	4,8	61	4,6	55	5,3	61
Firms with R&D under them: Continuous R&D	3,5	51	4,4	56	4,1	48	4,0	51	3,8	48	3,8	46	4,4	50
Occasional R&D	-	-	3,4	44	3,5	42	3,1	39	4,0	50	-	-	3,4	39
Employees (in Thsd.) amongst those: Innovators	-	-	1,9	25	2,2	26	1,4	18	2,2	28	-	-	2,0	23
amongst those: Product Innovators	-	-	1,5	19	1,4	16	1,6	20	1,7	22	-	-	1,3	15
Process Innovators	843	100	696	100	630	100	562	100	542	100	550	100	551	100
Firms with R&D under them: Continuous R&D	684	81	498	72	463	73	399	71	415	77	421	76	444	81
Occasional R&D	604	72	437	63	404	64	316	56	402	74	401	73	423	77
Innovation Expend. (in Bill. DM) Share of Turnover in %	514	61	411	59	377	60	286	51	319	59	366	66	392	71
under them: Continuous R&D	-	-	334	48	325	52	252	45	271	50	-	-	251	46
Occasional R&D	-	-	98	14	83	13	102	18	96	18	-	-	68	12
Current Innovation Expenditure	13,8	100	7,3	7,4	7,0	100	5,5	100	5,5	4,7	6,0	100	7,2	100
Capital Innovation Expenditure	15,5	-	-	-	6,2	-	4,6	-	4,7	4,6	4,6	-	5,0	-
Share of Firms with (Information in%) Market Novelties	3,2	23	2,9	40	2,7	39	2,1	39	2,3	42	2,2	37	3,7	51
Cost Reduction	10,6	77	4,4	60	4,2	61	3,3	61	3,2	58	3,8	63	3,6	49
Share of Turnover due to (Information in %) Market Novelties	-	-	-	-	21,6	-	24,0	-	20,8	-	20,9	-	24,4	-
Product Novelties	-	-	39,4	-	32,3	-	33,6	-	36,9	-	35,3	-	36,7	-
Share of Reduced Costs (Information in %)	38,0	-	37,1	-	35,4	-	30,9	-	32,4	-	33,7	-	36,3	-
	-	-	6,0	-	6,3	-	4,5	-	4,6	-	5,2	-	4,6	-

Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.

Comments: "-": Values not ascertained for that year. Values for 1998 preliminary. Turnover share due to product innovations for 1996 and 1998 only to a limited extent comparable to previous years. All information projected to the frame population in the New Länder of Germany.

### Research and Development in the New Länder 1993 to 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comment: Values for 1998 preliminary, not ascertained for 1997. All information projected to the frame population in the New Länder in Germany.

The East German share of companies engaged in R&D amount to 39% and is hence slightly higher than the corresponding value in the West, although size patterns of enterprises differs considerably in the two parts of Germany. Higher values result from payments effected through promotion programmes for R&D projects in the new Länder

However, the R&D activities are adapting to a large extent to the West German activities, which might be due to the fact that some promotion programmes are expiring. In contrast to the old Länder, particularly continuous R&D activities assume a higher importance, when comparing them to occasional ones. The share of enterprises carrying out R&D continuously amounted to 23%, and is hence still 3% points higher than the national average. In 1998, innovation expenditure in the new Länder rose by 20% to 7.2 billion DM, which is a more distinct increase than in manufacturing and mining in the whole of Germany. According to the planned figures of the companies, even a slightly increased innovation budget was implemented in 1999. Despite this considerable increase, East German enterprises account only for approx. 7% of the nation-wide innovation expenditure.

With respect to innovation intensity, the new Länder are at first sight in no way inferior to the old Länder. In 1998, the share of innovation expenditure in turnover rose by approximately 1/2 % point to 5%, compared to the value of the previous year. The nation-wide value amounted to a mere 4 1/2 %. This comparison neglects,

however, that many companies in the new Länder suffer severe problems on the markets. Higher innovation intensity is probably due to the more unfavourable turnover situation of East German companies than to a higher innovation inclination. Even though enterprises in the new Länder spend considerably less on innovation projects, their turnover share exceeds the national comparative value. Contrary to the development in the whole of Germany, the rise in innovation expenditure in the new Länder can be traced back exclusively to the rise in current innovation expenditure, which were raised in 1998 by almost 1 1/2 billion DM to more than 3 1/2 billion DM. In contrast to the old Länder, investments for innovation projects were not increased. In 1998, they even fell slightly by 0.2 billion DM to just 3 1/2 billion DM, compared to the previous year.

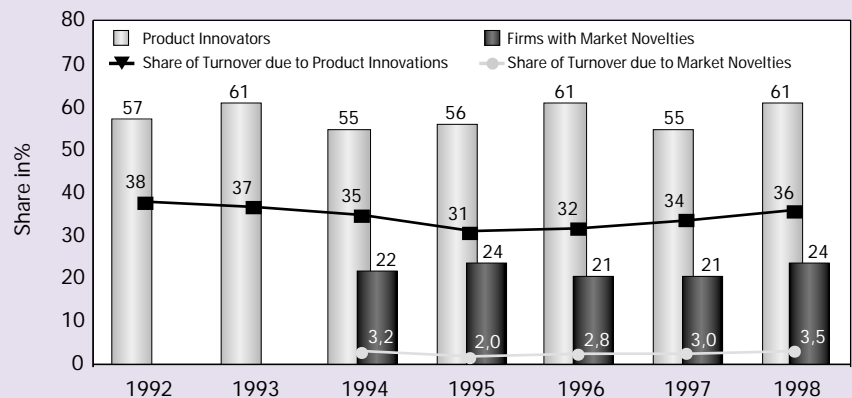
Nevertheless, in the new Länder investments continue to assume a more impor-

tant role within the innovation budget than in the old ones. The ratio between invested and current innovation expenditure is well-balanced in the new Länder in 1998; in the old Länder the share of capital innovation expenditure in total innovation expenditure is distinctly lower.

Innovation success also adapted to the nation-wide development in some respects. The turnover share due to product innovations increased in 1998 to 36% and approached the national share up to 3% points. Compared to 1995, the innovation success of East German companies increased steadily by a total of around 5% points.

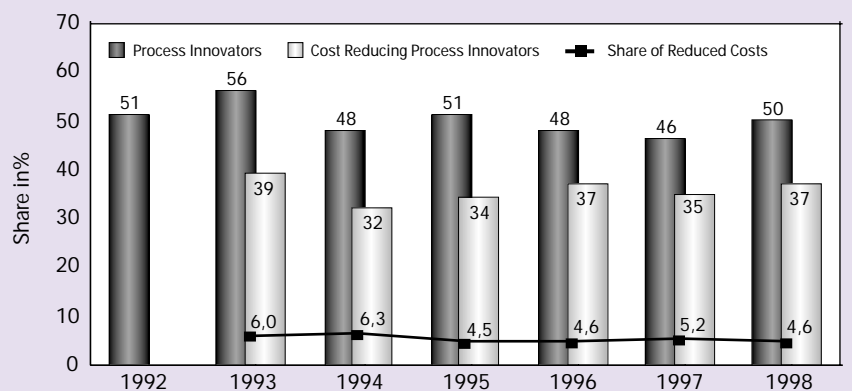
The share of companies with market novelties also developed to a large extent analogously with the nation-wide trend. In 1998, however, the increase by 3 1/2 % points to 24% turned out to be considerably lower than in the old Länder. Only time will tell, whether the differences will be

### Product Innovations in the New Länder 1992 to 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comments: Values for 1998 preliminary. Turnover share due to product innovations for 1997 and 1998 only to a limited extent comparable to the previous years. Market novelties not ascertained prior to 1994. All information projected to the frame population in the new Länder in Germany.

### Process Innovations in the New Länder 1992 to 1998



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining.  
 Comments: Values for 1998 preliminary. Cost reductions for 1992 not ascertained. All information projected to the frame population in the new Länder in Germany.



reinforced or whether the values will converge again.

The distinct deficit to market novelties demonstrates that the catching-up process has not been concluded yet. In the new Länder, turnover share due to market novelties (3½%) is significantly below the national average of 5½%, although the share increased by about 1½% points since 1995.

As in the development of market novelties, similar conclusions can be drawn from the cost-reducing process innovations, namely innovations based on a rationalisation motive. The share of companies, where the modernisation of production plants resulted in cost reductions, corresponds to a large extent to the value in West Germany. Until 1996, however, rationalisation innovations had a far higher importance in the new Länder than in the old Länder. In the meantime, the ratio between cost-reducing and total process innovations is on a par.

However, the share of cost savings has been far below the West German share now for three years. Compared to the previous year, it even fell in 1998, and with a value of 4½% it is a good 1½% points below the federal average. Process innovations are obviously less effective in the new Länder. In view of the fact that the new Länder's productivity is still lagging behind, it is questionable whether all rationalisation potentials are already exploited yet.

### Lack of Qualified Personnel Hampers Innovation

Companies are ever more frequently hampered in their innovation activities by factors for which they are not alone responsible. Compared to the 1997 survey, importance of all factors hampering innovations increased considerably in some cases. Effects of lack of qualified personnel are particularly critical. It is quite worrying that that lack of qualified personnel can assume such a high importance for innovation activities despite the continually high unemployment rate: in more than 10 thousand companies in manufacturing industry (16%), innovation activities are hampered, because adequately qualified personnel is not available. Meanwhile, this obstacle acquired about the same importance as lack of financial resources. Lack of qualified personnel principally results in delayed project terms.

But other severe consequences also arise: 6 thousand companies could not even start their innovation projects, that is twice as many companies as in 1996.

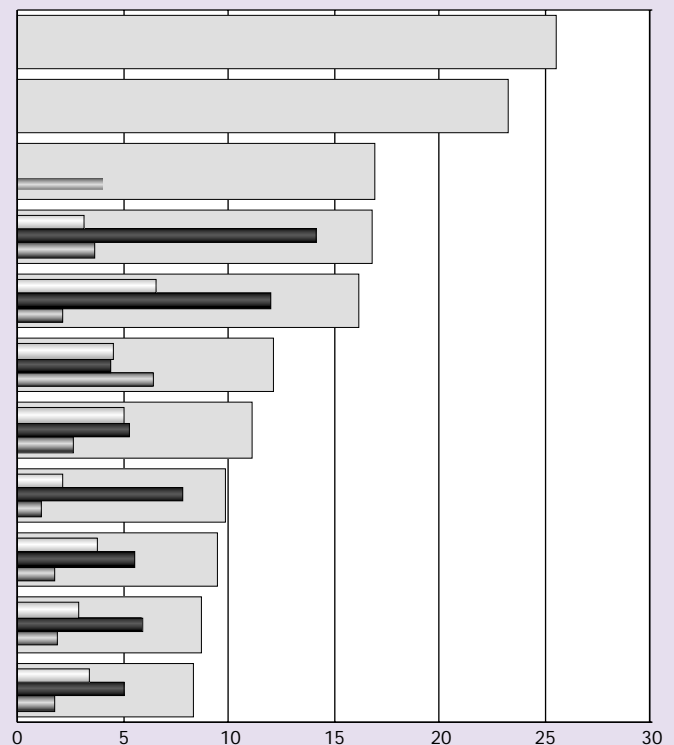
The importance of the lack of qualified personnel increases in parallel with the R&D-intensity of the industry. The project term is delayed in one out of four companies in economic sectors with high or very high R&D-intensity for this reason, i.e. three times as often as in companies with low R&D-intensity. In addition, one out of ten companies in research-intensive industrial sectors cannot even start innovation projects for want of adequately qualified personnel. In 1996, this was the case for one out of twenty companies (5%). Even in these highly innovative economic sectors – with an innovator share of 83% – innovation activities could potentially be increased even further.

Lack of qualified personnel is stated most frequently as a factor hampering innovation in industries of medical, precision and optical instruments engineering, motor manufacturing industry, as well as in electrical and mechanical engineering.

All these economic sectors typically have a large share of highly qualified employees, which include in most cases especially qualified engineers. Already two years ago, these economic sectors were most frequently affected by the lack of qualified personnel. The importance of this obstacle even increased above average in these economic sectors: while the share of affected companies rose, on average, by 6% points, the share in these economic sectors increased by 10-15% points to 25-35%. The considerable importance of shortage of qualified personnel as a factor hampering innovations demonstrates that innovation activities build not only to a large extent on the employees' qualification, but are also increasingly dependent on it.

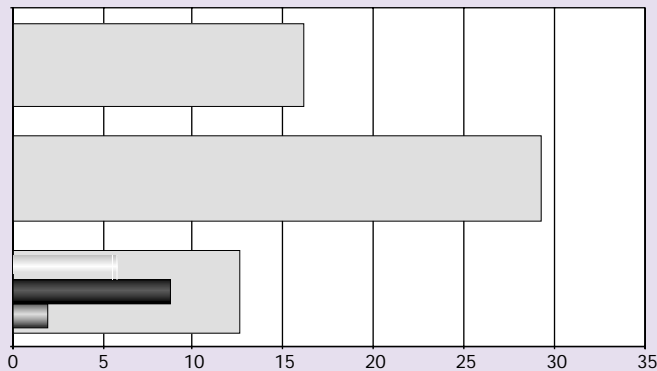
In the light of the considerable importance of lack of qualified personnel for the companies' innovation activities, the question arises, to which extent the companies try to eliminate this obstacle with their own means. Do the companies react for instance with an increase in further training expenditure?

Significance and Effects of Factors Hampering Innovation in Manufacturing Industry



Source: ZEW (2000): Mannheim Innovation Panel – Manufacturing and Mining. Comments: "n.a.": Hampering Factor surveyed 1998 for the first time. Values preliminary. All information projected to the frame population in Germany.

## Effects of Lack of Qualified Personnel by R&amp;D-Intensity



Descriptive statistics only show a weak positive correlation: In the group of companies with relatively high further training expenditure per employee, slightly more companies are affected by a shortage of qualified personnel (18%) than in the group of companies that spends little or nothing on further training of its employees (14%).

When investigating the correlation between the lack of qualified personnel and further training expenditure in a dynamic, multivariate model, no significant influence can be determined. Even if companies were affected by lack of qualified personnel as early as in 1996, further training expenditure per capita did not experience a noticeable increase until 1998. The multivariate estimation revealed that the correlation between obstacle and further training, as it was observed in descriptive statistics, is a spurious correlation. The causative influence of a variable can be proved or negated only when using regressions, whereas simple analysis of descriptive statistics always entails the risk that actually decisive effects of other variables are not considered.

When interpreting the results, however, one must take into account that further training expenditure do not include expenses for first time professional training. The question, whether lack of qualified personnel leads to reinforced training activities in companies hence would have to be analysed in a separate study.

The fact that lack of qualified personnel in the mentioned economic sectors – and not only in electronic data processing

(EDP) domain of service sectors – exerts such a large influence on innovation activities, raises the question as to whether shortage of qualified personnel in Germany is mainly limited to software developers. The statements of the companies actually give the impression that not only software developers are sought-after, but that also correspondingly qualified personnel is required that is able to apply new software and new developed technologies of the IT-sector to new processes and new products.

At first sight, the large number of unemployed engineers seems to be contradictory in connection with lack of qualified personnel. On the job market, however, one generation of employees is constantly replaced by a fresh generation. Development times are speeding up and rapid progress in the use of new technologies requires an ongoing updating of know-how. Extended phases of unemployment and thus ensuing devaluation of human capital make it more difficult particularly for older active persons to re-enter professional life.

Companies are, however, seeking qualified personnel with IT-expertise, namely persons that have experience in new technologies and are able to use them effectively in innovation processes. Like real capital, human capital can also become obsolete. Without continuing further training (e.g. due to unemployment), knowledge is also devaluated: for instance, user skills with respect to a specific software will be outdated within a few years, if they are not updated.

## Summary

As in the previous years, companies in German manufacturing and mining considerably increased their innovation endeavours. Following is an overview of the most important results of the ZEW innovation survey 1999:

- ▶ In 1998, the share of innovative enterprises increased once again by 3% points, and now amounts to 66%. This corresponds to more than 40 thousand companies, 39 thousand of which are small and medium-sized enterprises (SMEs) with less than 500 employees.
  - ▶ Employment continues to stabilise in innovative companies. In 1998, 5.8 million persons were employed in these companies. In manufacturing and mining as a whole, employment continues to fall.
  - ▶ The renewed increase of innovation activities is mainly based on an increase of process innovations. The share of companies that modernised or significantly improved their production processes rose by 5% points to 54%, whereas the share of product innovators remained nearly stable at high level.
  - ▶ A large share of companies that introduced new or significantly improved products onto the market, now acts as a genuine innovator and no longer as imitator. The share of companies introducing market novelties increased by 5% point to 28%.
  - ▶ Compared with other activities, and particularly with near-market innovation activities, R&D activities lost importance. The share of companies engaged in R&D declined in 1998 by 5% point to 38%, versus 1996.
  - ▶ Compared to last year, innovation expenditure rose by an additional amount of 6 billion DM to currently 109 billion DM. This corresponds to a turnover share exceeding 4<sup>1</sup>/<sub>2</sub>%. The increase of innovation expenditure is exclusively attributable to SMEs, which considerably expanded their innovation budgets by almost 30%.
  - ▶ Investments assumed more importance in innovation budgets. Capital innovation expenditure, which stagnated in the past years, rose substantially in 1998. 44 billion DM, namely 40% of total innovation expenditure were spent on investments.
- Companies in the new Länder (federal states in the East of Germany) adapted their innovation activities in many respects

to those of the West German companies. Existing differences are frequently due to different size patterns or a shortage of large enterprises in the new Länder:

- ▶ The share of innovative enterprises in the new Länder (64%) is only slightly below the nation-wide comparative value.
- ▶ The share of enterprises engaged in R&D is also falling like in West Germany. With a share of 39%, it is slightly higher than the federal average. The relatively high share of companies carrying out R&D continuously probably stems from the different ways of implementing promotion measures.

When evaluating the quality of innovation activities and the efficiency of innovation systems it does not suffice to analyse only the input of innovation processes. What is decisive, is the innovation result. The innovation success of German manufacturing and mining has to be evaluated in a differentiated manner:

- ▶ Turnover share due to new or improved products increased annually by 1% point to currently 39 1/2% since 1996. About 4 out of 10 DM are earned with new products.
- ▶ In this context, market novelties generate every twentieth mark of turnover. Compared to 1996, turnover share due to market novelties rose considerably, but it still is subject to strong fluctuations and kept its share constant at 5 1/2%, compared to the previous year. This corresponds to only one seventh of the corresponding value of the share acquired with new products, even though one out of three product innovators also launched market novelties.
- ▶ Innovation success of small and medium-sized enterprises partially lags behind that of large enterprises. Turnover share due to product innovations has hardly changed since the 90ies and currently amounts to approximately 30%. In contrast, the turnover share due to market novelties rose significantly and approached to a large extent the turnover share of the large enterprises.
- ▶ In the new Länder, turnover share due to product innovations (36%) approached the federal level up to 3% points. However, the catching-up process in the new Länder has not been concluded yet. It is true that 24% of the companies launched real novelties on the market, but they only generated 3 1/2% of the total turnover with these novelties. That is 1 1/2% points less than in the federal average.

▶ Process innovations are also less effective in the new Länder. The share of cost savings (4 1/2%) is a good 1 1/2% points below the national average.

Companies' innovation activities are hampered by various factors. In the current discussion, lack of qualified personnel becomes increasingly the focus of public attention:

- ▶ 16%, namely more than 10 thousand companies in manufacturing and mining, were considerably restricted in their innovation activities in 1998, because of lack of adequately qualified personnel.
- ▶ Shortage of adequately qualified personnel principally leads to the fact that companies cannot conclude their innovation projects within the projected term. On the other hand, the share of companies that could not even begin innovation projects due to lack of qualified personnel, more than doubled from 3 to 6 1/2% within in the past two years.
- ▶ Lack of qualified personnel occurs mainly in research-intensive economic sectors. They are affected nearly twice as often by specialist shortages as the average of manufacturing and mining. One out of ten of these enterprises was not even able to start an innovation project.
- ▶ Companies in the industries of manufacture of medical, precision and optical instruments, as well as in motor manufacturing industry, electrical and mechanical engineering are similarly often affected by the lack of qualified personnel as the EDP-sector in the service industry.

Lack of qualified personnel hence does not occur only in the EDP-sector in the service industry, but also hampers innovation activities in manufacturing industry. Companies themselves, however, cannot evade responsibility:

- ▶ Companies suffering from a lack of qualified personnel, do not engage in more further training activities than companies that find a sufficient supply of adequately qualified personnel on the job market.

### Conclusions for Innovation Policy

It becomes clear that the focus of the German industry continues to lie in the area of already established technologies which are continuously improved and are accordingly appreciated by the market. The German economy experiences some

difficulties when it comes to marketing new technologies or to market orientation of new products. Particularly small and medium-sized enterprises as well as companies in the new Länder have deficits regarding the market-orientation of their innovation activities. The importance of markets as innovation source is also frequently seriously underestimated in political discussions.

A reinforced market orientation of public innovation policy, namely indirect innovation support certainly point in the right direction for instance by reducing the tax load on R&D activities, as well as market orientation of direct innovation support, i.e. a project selection in analogy with the market.

Additionally, one should examine, which possibilities exist to complement pure R&D assistance through broader measures for innovation support, including particularly near-market forms of innovation activities.

The deficits in the market orientation of innovation activities are especially evident in the new Länder. The majority of innovation indicators clearly did indeed approach the indicators of the whole of Germany. Nevertheless, innovative products from East German enterprises are obviously less readily accepted by the market than those of their West German competitors. Particularly against this background, market-oriented targeting and complementing of state innovations is indispensable.

Innovation politics, however, should not forget that an expansion of innovation activities is only possible if the corresponding resources are available. Companies, however, are already lacking the required human capital for their innovation activities. Lack of qualified personnel does not occur only in the EDP-sector in the service industry, but also severely hampers innovation activities in manufacturing industry.

For this reason, the question arises whether measures, which solely aim at reducing lack of software developers, can adequately support the innovation capability of the German economy to the full extent. In many cases, not only pure EDP specialists are sought after, but also experts in other fields with corresponding EDP expertise.

Also in manufacturing industry, innovation activities build increasingly on the

qualification of all employees. Nevertheless, companies do not seem to tackle the lack of qualified personnel with the corresponding further training of the existing personnel.

Therefore, measures in educational policy have to support innovation policy together with companies, in order to ensure qualified human capital in the medium and long-run. In the light of the duration of the usual periods of study for adequately qualified personnel in Germany, it is necessary to be willing to take measures, whose effects will be felt only in a few years from now. Such measures include, for instance, the reinforced orientation of

educational contents towards the requirements of the market. Last but not least, the scientific environment at universities and technical colleges should be further improved in order to increase Germany's attractiveness as a research site.

Due to the extended internationalisation of the economy, Germany is increasingly in direct competition with a growing number of countries. Particularly so-called countries in transition are pressing on the interesting (interesting for them) German market with all their might. However, owing to the wage differential, German companies cannot sustain a pure price competition over a longer period of time,

but have to seek their chances in technology competition. In this context, it is more than critical that the share of overall economic expenditure in the domestic product that is spent on education and training, as well as on further training and R&D is continuously decreasing. In comparison, most of the industrial nations raised their investments in the creation of know-how and even exceeded their turnover increases. However, in view of growing importance of human capital for innovation activities, expenditure for education and training are important investments in the future competitiveness of the German economy. ◀

# ZEW

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IMPRESS

## The Mannheim Innovation Panel – Manufacturing and Mining

On behalf of the federal ministry of education and research (Bundesministerium für Bildung und Forschung, bmb+f), since 1993 the ZEW in collaboration with infas Institute for Applied Social Sciences has been conducting annual surveys on innovation behaviour of the German manufacturing and mining.

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