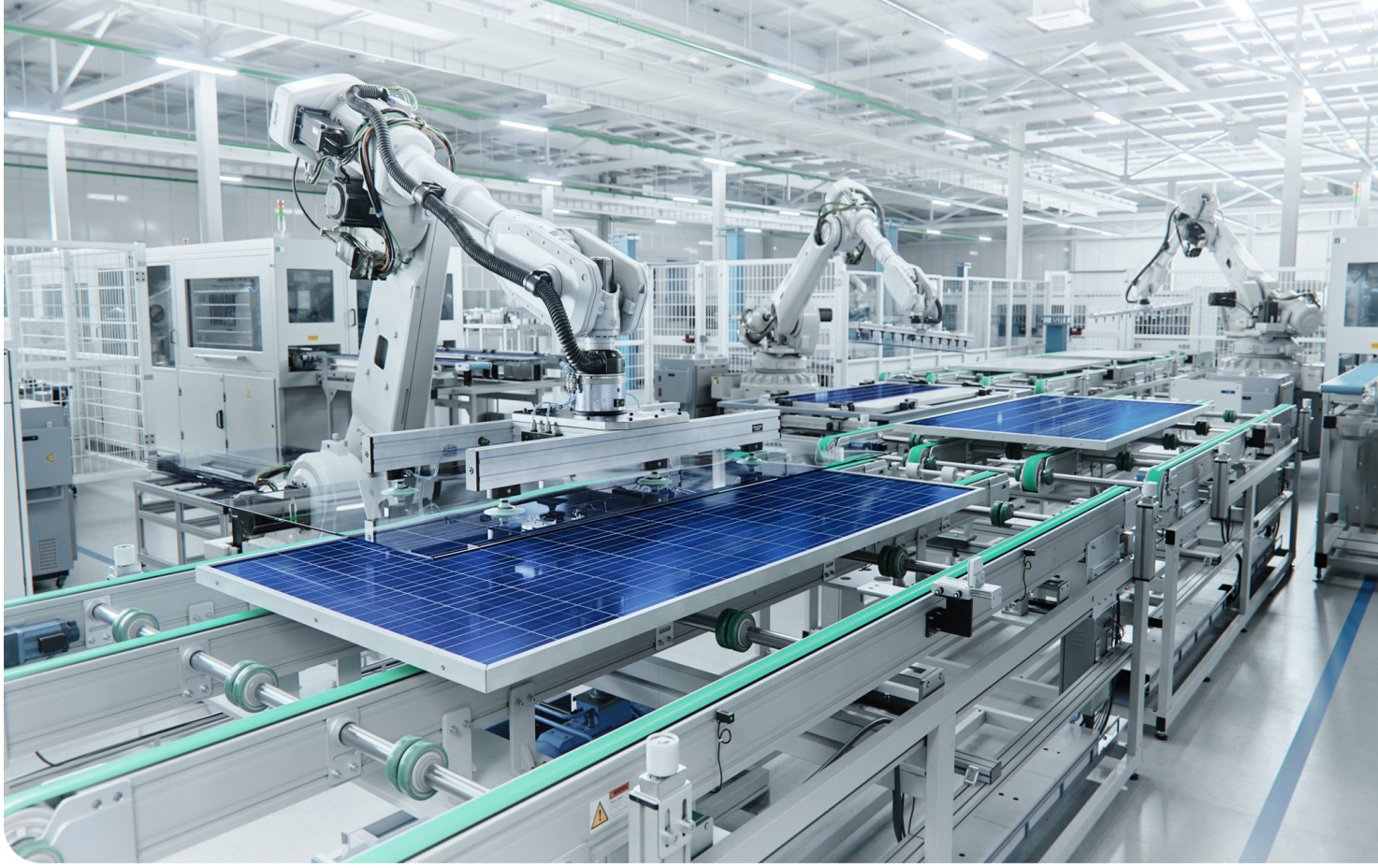


KfW Research

KfW SME Innovation Report 2023

SMEs' innovation activity has flatlined

Imprint

Published by
KfW
KfW Research
Palmengartenstrasse 5-9
60325 Frankfurt / Main
Phone +49 69 7431-0, Fax +49 69 7431-2944
www.kfw.de

Edited by
KfW
KFW Research
research@kfw.de

Author
Dr Volker Zimmermann
Phone +49 69 7431-3725

Frankfurt / Main, February 2024

Contents

Innovation activity in Germany's SME sector has not benefited from the subsidence of the COVID-19 pandemic. The innovator rate stands unchanged at 40%. Innovation expenditure still sits at EUR 34 billion in current prices, as it did in the previous year. This means spending on innovation, adjusted for inflation, fell slightly. Two main reasons have likely contributed to this development. First, some of the negative effects of the COVID-19 pandemic are still lingering. Second, the economic prospects for small and medium-sized enterprises, which exert a strong influence on innovation decisions, clouded over already in the spring of 2022. The development of innovation activity therefore differs substantially from that of investment.

The subdued development is partly due to the fact that the trend towards less innovation without R&D that already became apparent in recent years still continues (-2 percentage points since the previous year's survey). Besides, businesses with international sales, in particular, which are typically strong innovators, are scaling back their innovation activity (-3 percentage points). For the latter ones, flagging export performance is likely to be the main reason.

The development of new or improved products (in a narrower sense) and services and the further development of digital technologies/supporting methods in administration and non-technical innovations such as marketing methods as well as work and business organisation contribute to the innovator rate to a comparable degree. The innovator rates for these aspects range between 21 and 23%. Only the rate of innovators that improve or modernise their manufacturing processes in a narrower sense is lower, at 14%.

Innovation activity in Germany can be stimulated with targeted economic policy support for peak segments and the broad business community. Starting points for economic policy measures are, in particular, business segments that have previously been addressed less strongly, and the key barriers hampering innovation activity.

Financing-related barriers present a hurdle for all SMEs. Financing difficulties for pioneering businesses can be mitigated by expanding support for research and development (R&D). The vast portion of innovation activity across the broad SME sector is based on experience-based skills. Innovations typically emerge from SMEs' normal day-to-day business and without any R&D. Financial support for these enterprises must therefore address expenditure on product design and service design.

Easing skilled labour shortages is also of great importance. All actions that improve the supply of skilled workers in the German labour market also constitute indirect innovation support measures. These can range from measures adopted in schools through vocational and academic training and education to activating the domestic workforce and migration policy. What is cause for concern is that basic literacy and numeracy skills of school students are dropping. Furthermore, innovative businesses face insufficient social and digital skills as major recruitment barriers. With respect to vocational training, existing hurdles must be lowered for small and medium-sized enterprises in particular, which must be made more attractive as businesses that provide training. With respect to continuing education and training, it is important to realise the guiding principle of 'lifelong learning'.

Economic policy responses include not just increasing the supply of skilled labour but developing the specific skills required to carry out innovation projects. More broadly, they need to support in-house processes of learning and understanding, for example by offering advice and, where necessary, financial support for the introduction of appropriate management practices, improving incentives for innovation or knowledge flows into and within the enterprise.

Last but not least, a company's innovation activity can be stimulated by strengthening its strategic capabilities. Many small businesses with well-established but not very innovative business models pay little attention to the aspect of strategic business development because their day-to-day business is the main priority. This often prevents them from seeing the need to focus on innovation.

1. Introduction

Innovation is the driver of growth and prosperity

Innovation accelerates economic growth and productivity developments across the broad economy; it drives the structural transformation.[1] In developed economies, innovation is therefore regarded as the guarantor for safeguarding and increasing prosperity.[2] Germany in particular, a highly developed country with few natural resources to call its own, must therefore secure its technological leadership or, where possible, take a leadership role in key business areas in order to be internationally competitive. Innovation is also important because it contributes to addressing societal challenges such as climate change, healthcare provision and the consequences of demographic change.

From a business perspective, innovating is an important strategy for developing a competitive position in the market. It creates new sales potentials and improves the use of resources. Numerous studies confirm that innovation increases enterprises' headcount, turnover, returns and productivity.[3] Successful innovation activity not only secures business success but benefits the employees of the enterprises involved. Innovators pay higher salaries[4] and offer more stable employment relationships, even if they reduce employment overall.[5]

The German innovation ecosystem in international comparison

Germany's innovation ecosystem is generally quite well positioned in international innovation ranking indices. In the Global Innovation Index, for example, Germany ranks 8th of 132 countries. Other rankings and additional studies for Germany paint a similar picture.[6]

The strengths of Germany's innovation ecosystem consist in a strong research sector and extensive R&D activities in large enterprises. Over the past one and a half decades, Germany was able to make significant progress in R&D activities in particular.[7] However, a fly in the ointment is that since the beginning of the COVID-19 pandemic no progress has been made in reaching the R&D expenditure target of 3.5% of GDP.

The transfer of knowledge and technology is particularly effective between the academic sector and large enterprises that conduct R&D in traditional business sectors. In new technologies and start-ups, however, there is room for improvement. Furthermore, the concentration of innovation activity in increasingly fewer businesses is a sign of weaknesses in the diffusion of knowledge, particularly to small and medium-sized enterprises.[8]

Innovation is more than research and development

Three key features define innovation: A product innovation must be introduced in the market, or a process innovation in the enterprise ('implementation'). Second, the innovation must be new or significantly improved from the viewpoint of the innovating enterprise ('subjective view'). Finally, the innovation must clearly stand out from the company's previous practice or offerings. Minor changes therefore do not constitute an innovation ('noticeable difference').[9]

Specific examples of innovation include a novel manufacturing process for components for generating green hydrogen more efficiently and cost-effectively, a novel brain pacemaker for reducing epileptic seizures implanted directly under the scalp, or a lorry trailer with a lowering function, rear support and three-way tipping mechanism.

Innovations are not limited to novelties based on R&D. Small and medium-sized enterprises, in particular, often develop innovations out of the normal production process or in cooperation with customers and suppliers without conducting any research ('learning by doing, using and interacting').[10] Innovating can also mean adapting products and services to specific customer requests and usage environments. The further development and adaptation of innovations and the diffusion of new technologies by businesses have an important role to play. Not least, this ensures that the overall economy remains competitive.

2. Development of the share of innovators among SMEs

Innovator rate did not benefit from the economic recovery in 2022

The innovator rate among SMEs remains unchanged at 40% (Figure 1).[11] It measures the share of enterprises that have introduced at least one innovation in the past three years. The number of innovative SMEs thus stands unchanged at around 1.5 million enterprises. Under the new OECD definition, the innovator rate now includes not just companies with technical innovations but also those with marketing and organisational innovations (box: New OECD innovation definition). A direct comparison with the survey results from before the 2018–2020 period is therefore not possible.

New OECD innovation definition

The accepted definition of innovation was developed by the OECD in collaboration with Eurostat. It forms the basis for measuring innovation activity in the EU and many other countries and it is also used in the KfW SME Panel.

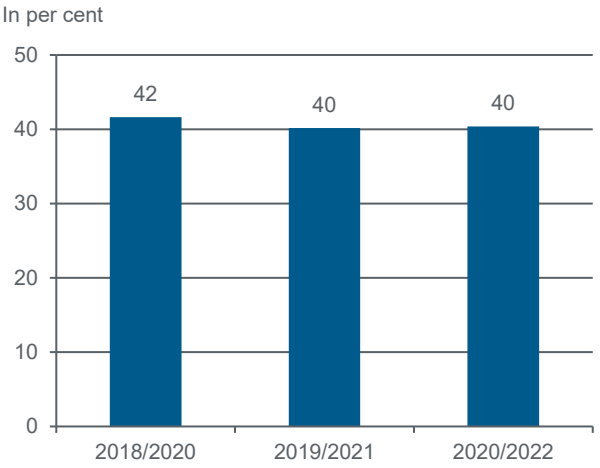
The definition of innovation was revised in the year 2018.[12] New marketing methods and new organisational methods now also count as product or process innovations. The vast majority of marketing and organisational innovations are classified as process innovations. Significant changes in design, however, are counted as product innovations.

The KfW SME Panel has taken this definition into account since the 2021 survey. The expansion of the definition of innovation means that the share of innovators measured is typically higher – for example, when the economic environment has remained unchanged – than before the definition was modified.

Thus, unlike the share of enterprises with (physical) investments, the innovator rate did not benefit from the economic recovery that came with the subsidence of the effects of the COVID-19 pandemic. Thus, the share of SMEs investing in assets rose by 5 percentage points to 43% after the slump in the second year of the pandemic.[13] The innovator rate, by contrast, remains on the lower level after decreasing in the second year of the pandemic.

The decline in the innovator rate in the second year of the pandemic is likely due to the fact that after an initial innovation surge, companies that were in a tight liquidity situation and those expecting a prolonged crisis, in particular, scaled back their innovation activities in the further course of the crisis.[14] The pandemic also represented a phase of heightened uncertainty, so that many enterprises likely deferred decisions around the implementation of innovation projects, even when they were not directly affected by the pandemic.[15]

Figure 1: Development of innovators among SMEs



Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

Then in 2022, the German economy recovered strongly, kickstarting investment activity. The innovator rate, however, remained on the previous year's level. A likely major reason for this was that the pandemic negatively affected businesses' innovation processes not just in the short term but also in the medium term. The pandemic likely hampered innovation activity through various channels. Among other things, social distancing measures led to less face-to-face interaction and, hence, a more limited exchange of knowledge within enterprises. As a consequence, fewer innovative ideas were likely developed, so that innovation activities in the affected enterprises decreased into the year 2022, as demonstrated by a recent study.[16] In this context, the authors speak of 'long-COVID symptoms' with regard to innovation activity.

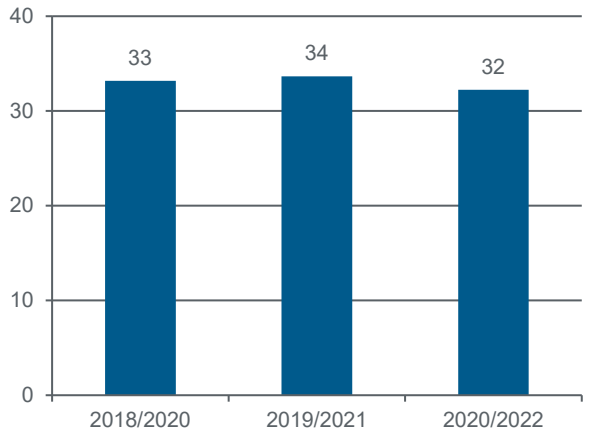
In addition, the business expectations of enterprises had already clouded over in the spring of 2022, as shown by the KfW-ifo SME Barometer,[17] but also by the 3-year turnover expectations surveyed under the KfW SME Panel. SMEs' profit margins were also lower in 2022 than in the previous year.[18]

In past surveys, 3-year turnover expectations as well as profit margins proved to be important factors

determining innovation activities in the course of the business cycle.[19] Thus, businesses are most likely to innovate when they have positive economic expectations. In an optimal case, a business innovates during an economic upswing. The reason is that in such phases it is easier for product innovations to penetrate the market and (novel) processes tend to be more profitable because they run at higher capacity during such phases. Besides, innovation activities can be financed more easily in such phases, for example with higher profits and better access to bank loans.[20]

Figure 2: Development of innovators without R&D

In per cent



Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

Share of innovative businesses without R&D is falling

The majority of SMEs that innovate are companies that have no R&D activities of their own. As mentioned above, these businesses develop innovations out of the normal production process or in cooperation with customers and suppliers ('learning by doing, using and interacting'). They do this using external knowledge and informal learning processes based on intensive exchange within the enterprise, for example. Most of these innovations are incremental enhancements or imitative innovations. They make up an important share of the diffusion of innovations across the economy. Particularly in these businesses, social distancing measures can seriously disrupt the generation of ideas.

The share of innovators without R&D in the SME sector currently stands at 32% (Figure 2). With a drop of 2 percentage points on the previous survey and 1 percentage point on the first year of the pandemic, this is a moderate decline. But it does signify the continuation of a trend that could already be observed in the previous decade. According to calculations made on the basis of the innovation survey conducted by the Centre for European Economic Research in Mannheim, the share of SME innovators without R&D (including organisational and marketing innovations) fell by a total of 9 percentage points, or around one sixth, between the years 2010 and 2020.[21]

Large enterprises innovate more often

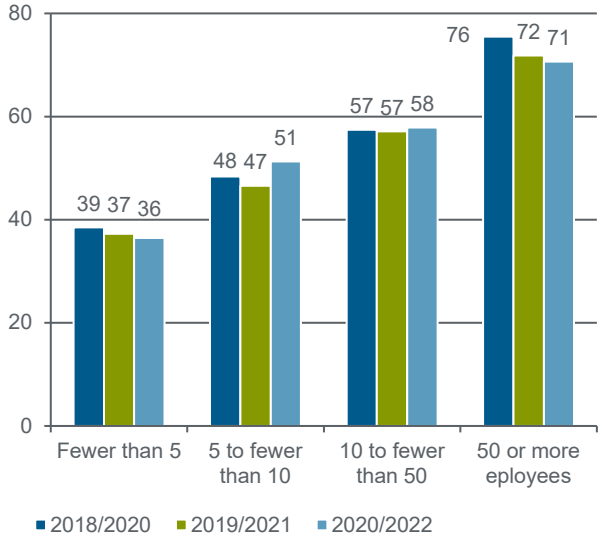
With respect to company size, the analysis paints the familiar picture that the share of innovators grows with the size of the enterprise. At 71%, the share of innovators in the group of companies with 50 or more employees is today almost twice as high as among small businesses with fewer than five employees (36%, see Figure 3).[22]

This is because small businesses have fewer resources and cover smaller markets.[23] That makes it harder for them to innovate and reduces profits which they could generate from innovating. These disadvantages are exacerbated by the fact that innovation projects often cannot be split up at will.[24] Minimum project sizes and high fixed costs mean that innovating places a higher financial strain on small enterprises than on larger ones.

Figure 4 illustrates this. For example, 83% of large SME innovators (with 50 and more employees) spend less than 2% of their annual turnover on innovation. Among SMEs with fewer than five employees, however, that share is 40%. In return, 18% of small businesses spend 15% and more of their turnover on innovation, while that share is a mere 1% among large SMEs. The higher relative burden also means that small SMEs cannot carry out as many innovation projects at the same time. This means they are less able to diversify their innovation risks across a broader innovation portfolio than large enterprises.

Figure 3: Innovators by company size

In per cent

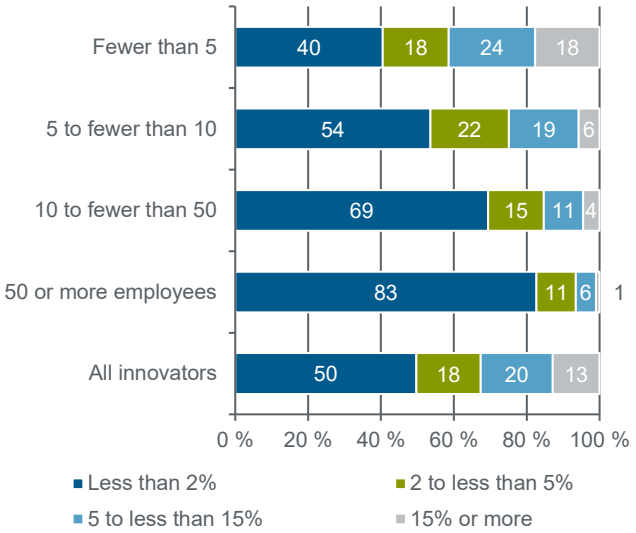


Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

Figure 4: Innovation expenditure as a percentage of annual turnover by enterprise size

In per cent



Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

Development of innovator rate varies by company size

Unlike in the previous year, the innovator rates developed unevenly among the various company size classes. Whereas the innovator rate among small businesses with fewer than five employees and large SMEs with 50 and more employees dropped slightly by -1 percentage point for the second consecutive year, the innovator rate among medium businesses with five to fewer than 50 employees grew moderately. The decline in innovation activity among small businesses is consistent with the observation that they in particular were affected more severely and, overall, more frequently by turnover losses at the beginning of the pandemic.[25] Thus, the share of businesses that are vulnerable to 'long-COVID' symptoms around innovation activity is high in this group in particular. Besides, the business expectations of small businesses had already deteriorated in the spring of 2022.

Internationally active businesses are deferring innovation

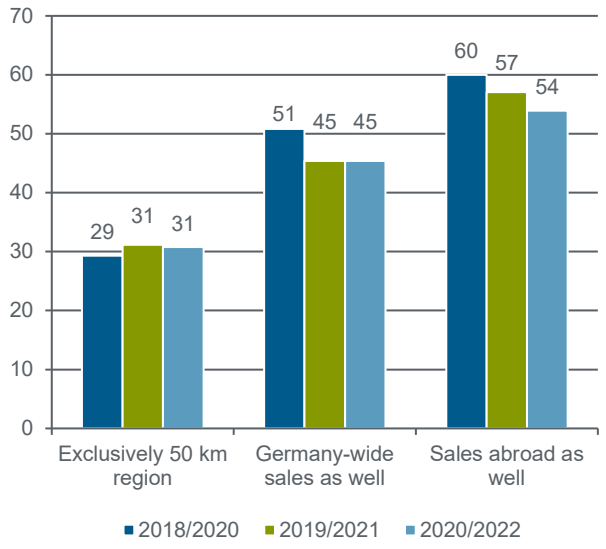
A look at the particular region in which businesses generate their turnover goes a long way to explaining the current development of innovation activity among large SMEs. While the innovator rate is currently steady among enterprises that operate exclusively in their home region and across Germany, that rate fell for the second straight year among those that also operate internationally (Figure 5).

At the beginning of the pandemic, internationally active businesses were affected by turnover losses particularly often and slightly more severely than others[26], so it is safe to assume that a particularly large share of enterprises is susceptible to 'long COVID' symptoms in this group, too. What also likely plays a role at the current margin is the significant deterioration of the geopolitical situation since Russia's war of aggression against Ukraine and the weak economic performance of Germany's export markets. Supply bottlenecks have also increased again since autumn 2022,[27] which likely affected internationally active enterprises more than others.

As a consequence, the business expectations of affected enterprises had already deteriorated in the spring of 2022. According to the KfW-ifo SME Barometer, SMEs' export expectations also deteriorated significantly with the start of the war and continued to fall in the course of the year.[28] Large SMEs, which are more active internationally than smaller businesses, are likely to be particularly affected. The slight decline in the innovator rate among large SMEs therefore probably also has to do with the weakness of export markets.

Figure 5: Innovators by sales region

In per cent



Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

Despite the declining trend among internationally active businesses, the pattern remains that the larger the geographic extension of the sales region, the higher the innovator rate. The influence of exports as a catalyst of innovation, in particular, was demonstrated by various studies in the past.[29] The more intensive competition in supra-regional sales markets is likely to be a driver of this. Intense competition forces German enterprises to offer products with superior attributes and keep their processes efficient. In addition, their presence in international markets is a source of new knowledge and ideas that can drive innovation activity.[30]

R&D-intensive manufacturing and knowledge-based services have the highest innovator rate

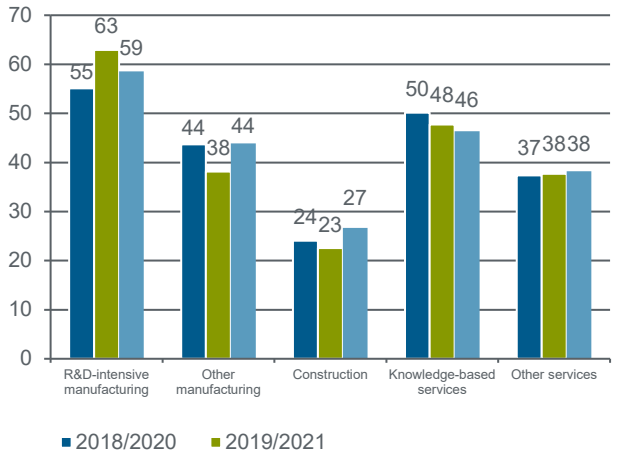
An analysis by sector shows that R&D-intensive manufacturers (for example, in mechanical engineering, electrical engineering and the chemical industry) generate the most innovations (Figure 6). The share of innovative enterprises in R&D-intensive manufacturing currently stands at 59%. Knowledge-based service providers such as IT and information service businesses, law firms, tax accountants and management consulting firms come in second – as they did in the past years – with an innovator share of 46%. They are followed by other manufacturing industries, which comprise the food and animal fodder production and metal products industries, and other (non-knowledge-based) services such as hospitality, transport and storage, with 44 and 38% respectively. Construction ranks fifth at 27%.

Innovator rate is on the decline in sectors with strong innovation activity

Economic sectors that typically are strong innovators currently experience a declining innovator rate. The share of innovative enterprises has dropped by 4 percentage points in R&D-intensive manufacturing and by 2 percentage points in knowledge-based services. At the same time, however, it must be noted that, with a share of 59%, the innovator rate in R&D-intensive manufacturing nonetheless continues to be higher than in the first year of the COVID-19 pandemic.

Figure 6: Innovators by industry

In per cent



Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

The likely reasons for this are that in all economic sectors under consideration here with the exception of the construction sector, expectations regarding business development had already fallen in the spring of 2022. Furthermore, R&D-intensive manufacturing and knowledge-based services also saw a drop in profit margins in 2022. Particularly in R&D-intensive manufacturing, the weak performance of exports is also likely to have a dampening effect on innovation activity.

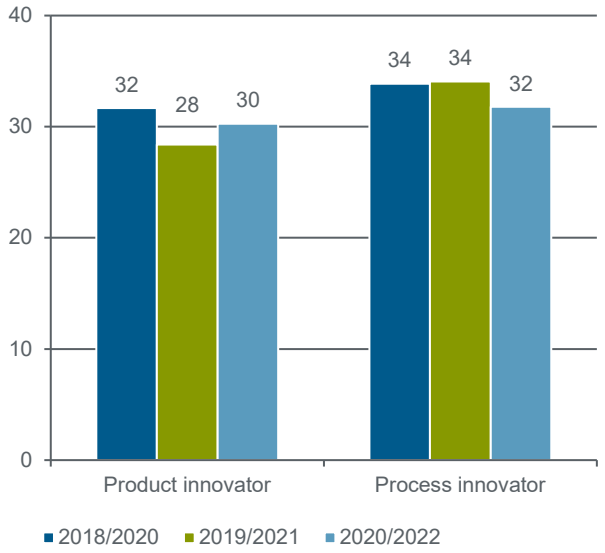
It is only in the construction industry that the share of innovators grew and is now higher – at 27% – than at the beginning of the pandemic. It must be taken into account that construction firms were least affected by the impacts of the pandemic[31] and therefore rarely had to take countermeasures when it broke out. In other services, the innovator rate remained unchanged on the previous year's period, while in other manufacturing that rate has now returned to the level recorded in the first year of COVID-19, after innovation activity had fallen in the course of the pandemic.

Product innovations recovered from the slump in the second year of the pandemic

For product and process innovators, the corresponding shares are 30 and 32%, respectively (Figure 7). Thus, a good 1.1 million SMEs currently bring new or improved products (including services) to market. Just under 1.2 million modernised their processes or introduced organisational innovations or new marketing methods.

Figure 7: Development of SME product and process innovators

In per cent



Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

The pandemic-induced slowdown of innovation activity[32] saw SMEs scale back product innovations in particular. Product innovations increased again moderately as they overcame the effects of the pandemic. However, the current product innovator rate of 30% means that they have not yet returned to the level of the first year of the pandemic. The deterioration in business expectations likely put the brakes on the catching-up process in product innovation.

Process innovations, however, were generated by SMEs on the same level in the second year of the pandemic. Thus, they continued to introduce changes and enhancements of processes (including organisational and marketing innovations) in the second year of the pandemic as well. The rate of process innovators dipped only slightly as a result of deteriorating business expectations in 2022.

Individual types of innovation saw different rates of development

The types of innovations generated can be examined in more detail with the aid of the KfW SME Panel. Figure 8 illustrates that the innovator rates stood at similar levels in the past three survey waves – between 20 and 25% – with regard to physical products (i.e., goods including digital products), service innovations (including digital services), data processing methods and supporting administrative procedures as well as non-technical innovations (such as organisational and marketing innovations). Only the rate of innovations in manufacturing processes was significantly lower, with levels ranging from 12 to 15%.

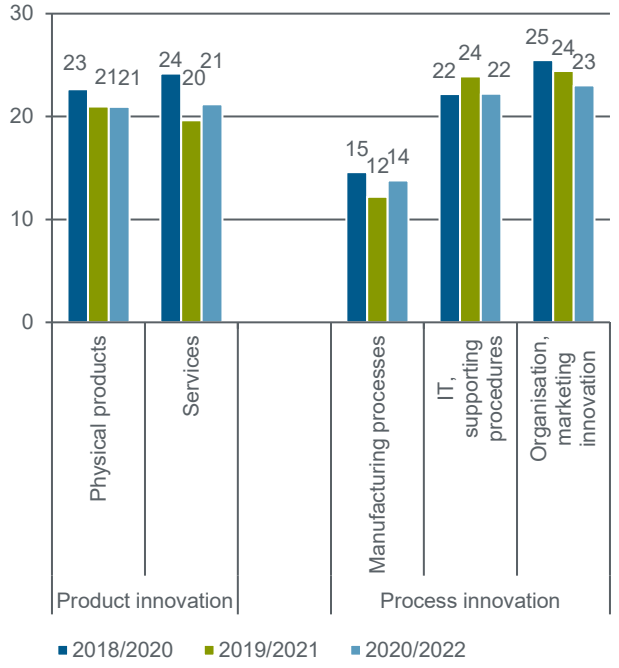
With regard to product innovations, the creation of both physical products and services was particularly pronounced in the first year of the pandemic, with rates of 23 and 24%, respectively. Both types of innovation were less common in the second year of the pandemic, while the increase in the rate of product innovators at the current margin was triggered solely by a minor increase in service innovations (+1 percentage point). The findings for the years of the COVID-19 pandemic are consistent with the results of past studies which identified strong innovation activity at the beginning of the pandemic in particular.[33]

At the beginning of the COVID-19 pandemic, organisational and market innovations as well as improvements to production processes were the process innovations that were generated more often than in the following years (25%). The rate of non-technical innovations (that is, organisational and marketing innovations) has since been on a downward trend. This development was likely due primarily to the fact that businesses had a need to adopt such measures at the beginning of the pandemic in order to stay in business and remain visible even amid pandemic conditions.

The rate of innovations in manufacturing processes decreased particularly in the second year of the pandemic (-3 percentage points). Further adjustments to manufacturing processes likely played a secondary role in overcoming the crisis in the second year of the pandemic and were likely put last as innovation activity slowed. The share of businesses with innovations in manufacturing processes is currently recovering slightly.

Figure 8: Development of SME product and process innovators

In per cent



Note: Figures extrapolated on the basis of the number of enterprises; new OECD definition: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

By contrast, data processing and supporting methods in administration peaked at 24% in the second year of the pandemic. The pandemic triggered a surge in digitalisation that even intensified in its second year.[34] This likely also included a higher share of projects which businesses classified as innovations.

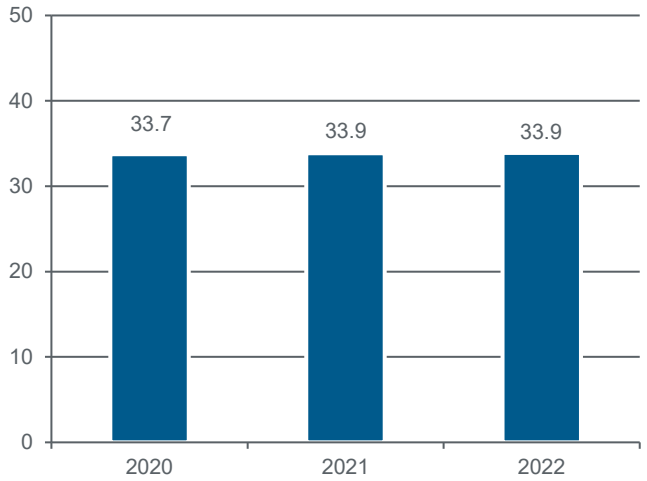
3. Development of innovation expenditure

Innovation expenditure did not increase after the COVID-19 pandemic abated

Innovation expenditure has remained nearly steady for the third straight year. Aggregate innovation expenditure of SMEs currently sits at just under EUR 34 billion (Figure 9). This includes all spending on innovation including personnel costs and capital expenditure related to developing innovations and bringing them into the market.[35] Thus, innovation expenditure remained unchanged on the previous year in nominal terms. If we take price increases into account, innovation expenditure has dropped minimally to EUR 32.6 billion.[36] Innovation expenditure therefore has not been able to benefit from the subsidence of the pandemic either. Here, too, the 'long COVID' problem described above and the softening of business expectations have likely been the trigger that put the brakes on the development of innovation activities.

Figure 9: Aggregate innovation expenditure in the SME sector

In EUR bn



Note: Nominal values, extrapolated on the basis of the number of employees, new OECD definition: Innovation expenditure inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

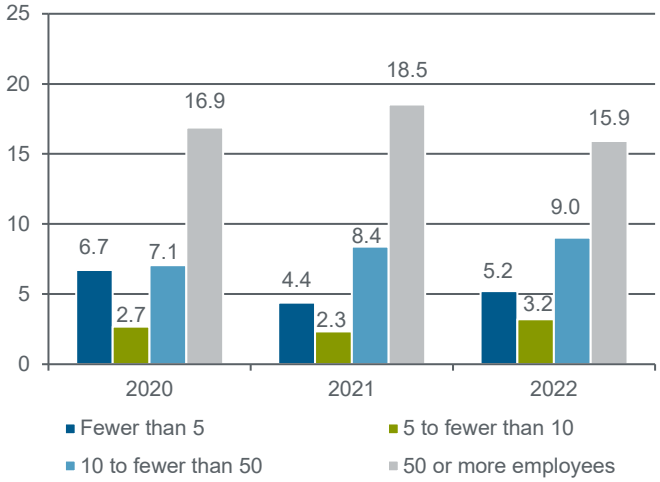
The development of innovation expenditure thus also contrasts with the development of (physical) investments. Investment expenditure increased by just under 12% in nominal terms on the previous year[37] and by a still notable 3.5% when adjusted for prices.[38] That means SMEs spent more than seven times more in physical assets than on innovation projects in the year under review.

Large SMEs reduced their innovation expenditure

The nearly unchanged level of nominal innovation expenditure in the SME sector conceals the fact that small and medium-sized enterprises expanded their innovation expenditure moderately, while large SMEs slightly reduced their innovation expenditure on the previous year, to just under EUR 16 billion (Figure 10).

Figure 10: Aggregate innovation expenditure by enterprise size

In EUR bn



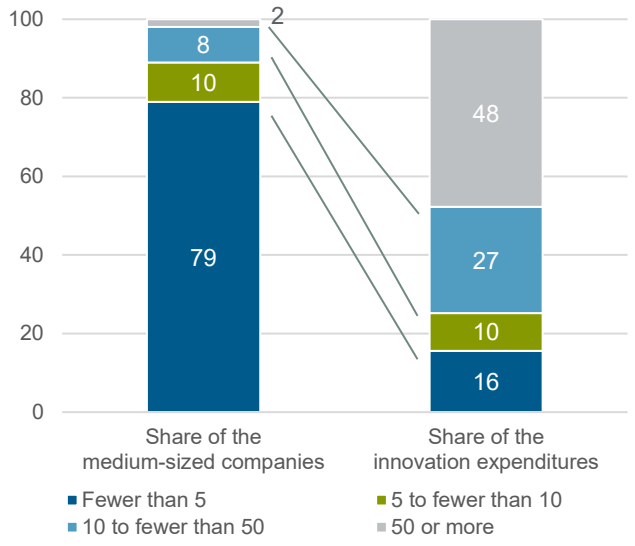
Note: Nominal values extrapolated on the basis of the number of employees, not counting enterprises of the remaining economic sectors, new OECD definition: Innovation expenditure inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

However, that means SMEs' innovation expenditure remains heavily concentrated in the group of large SMEs (Figure 11). Thus, large companies with 50 and more employees account for 48% of innovation expenditure in the SME sector, even though this group represents only 2% of small and medium-sized enterprises. A further 27% of innovation expenditure is attributable to the group of businesses with 10 to fewer than 50 employees, which makes up 7% of SMEs. At the opposite end of the distribution, 79% of enterprises with fewer than five employees account for a mere 16% of SMEs' innovation expenditure.

Figure 11: Concentration of innovation expenditure in the SME sector

In per cent



Note: Nominal values; extrapolated on the basis of the number of employees, not counting enterprises of the remaining economic sectors, new OECD definition: Innovation expenditure inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

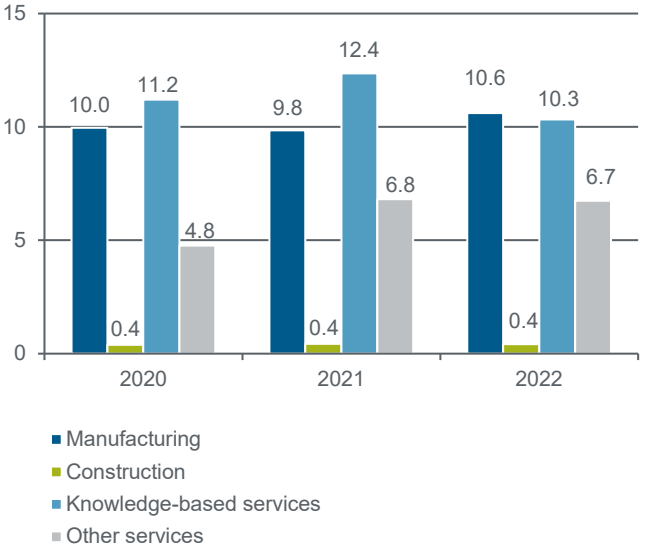
Manufacturers and knowledge-based service providers spent the most on innovation

By sector, manufacturers spent the highest amounts on innovation, EUR 10.6 billion, closely followed by knowledge-based service providers with EUR 10.3 billion (Figure 12). Knowledge-based services represent 38% of SMEs, the largest share of all enterprises in this group. Manufacturers, on the other hand, make up only 5% of SMEs. Thus, in relation to the number of enterprises, manufacturers in particular inject high financial resources into the businesses' innovation activities. Ranked third at some distance are other services, with just under EUR 7 billion. Innovation expenditure was lowest in the construction sector, at EUR 0.4 billion.

Compared with the previous year, there was little variation in the level of expenditure between the various economic sectors. The greatest change was the moderate decline in innovation expenditure among knowledge-based service providers, which contrasts with a minor increase among manufacturers.

Figure 12: Aggregate innovation expenditure by sector

In EUR bn



Note: values extrapolated on the basis of the number of employees; not counting businesses with fewer than five employees, new OECD definition: Innovation expenditure inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

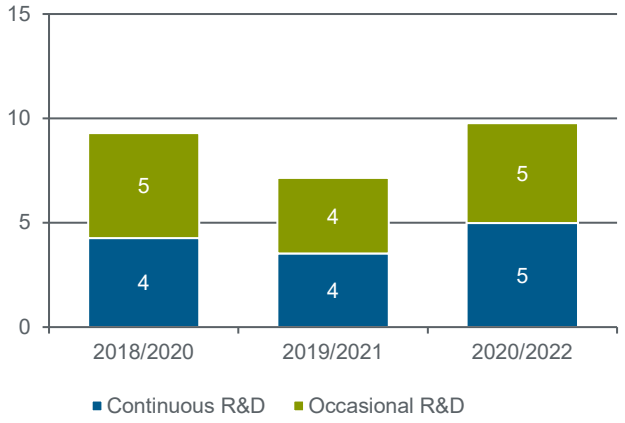
4. Development of R&D activity

SMEs rarely conduct own R&D

As described above, many SMEs innovate without conducting any R&D of their own. R&D is defined as 'systematic creative work aimed at expanding existing knowledge [...] and using it with the objective of finding new potential applications'.[39] Instead, it is common for SMEs to develop innovations on the basis of experience-based knowledge that emerges from the normal production process or in collaboration with customers and suppliers.[40]

Figure 13: Enterprises with research and development activities of their own

In per cent



Note: Figures extrapolated on the basis of the number of enterprises.
Source:

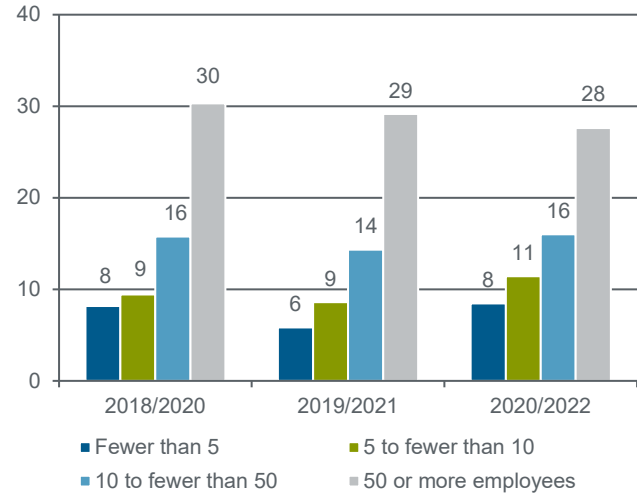
KfW SME Panel, own calculations

In the 2020–2022 period, a mere 5% of SMEs conducted R&D continuously and a further 5% occasionally (Figure 13). In absolute figures, that means just under 400,000 SMEs conducted R&D of their own. Both shares increased by 1 percentage point since the previous survey. This minimal increase in R&D-active businesses likely bolstered innovation activity and counteracted the decline in businesses without R&D (Figure 3). In terms of innovation activity, that means a total of around 79% of innovative SMEs bring out new or improved products and processes without performing any R&D activities of their own. At the same time, 21% of innovative SMEs carry out own R&D activities occasionally or continuously (Figure 18 in the annex).

Even if the group of SMEs with R&D activities is comparatively small, it does play an important role in the innovation ecosystem. This is because enterprises with R&D activities are, to a certain extent, at the spearhead of innovation in the SME sector. They bring out innovations particularly often and in many cases with a high degree of novelty.[41] With their innovations, these enterprises often bring new ideas to market and, thus, make a particularly important contribution to technological progress and the structural transformation.

Figure 14: Enterprises with own (occasional or continuous) R&D by size

In per cent



Note: Figures extrapolated on the basis of the number of enterprises.
Source:

KfW SME Panel, own calculations

Share of SMEs engaged in R&D rebounded across almost all size classes

Large SMEs are much more likely to perform their own R&D than other enterprises. In the period under review, 28% of SMEs with 50 or more employees conducted their own R&D, compared with 8% of enterprises with fewer than five employees (Figure 14). In other words, large SMEs are 3.5 times more likely to conduct R&D than enterprises with fewer than five employees. This is an indication that larger enterprises undertake innovation activities more systematically and that their innovation processes are more permanent.[42]

The moderate recovery in the share of companies conducting R&D can be observed in almost all enterprise size classes. Large SMEs are the only ones where the share has dropped minimally. The weak export performance is also likely to have put a handbrake on these businesses' R&D activities.

R&D-intensive manufacturing SMEs are most likely to conduct own R&D

R&D-intensive manufacturers are by far the most active in conducting own R&D, leading all other sectors by a wide margin (Figure 15). At present, 33% of SMEs in this sector continuously or occasionally conduct R&D of

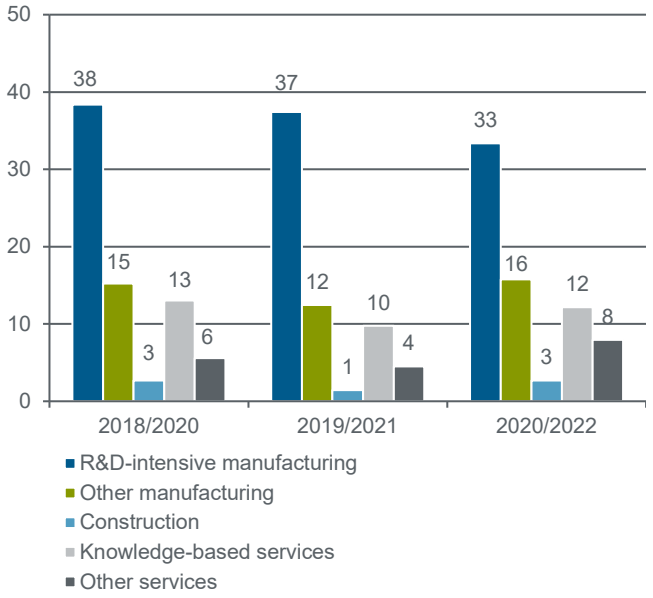
their own. This is a higher level than in the other economic sectors and forms the basis for the high share of innovators. In-house R&D activity is likely to boost the generation of technical innovations in particular.

There are hardly any differences between other manufacturing and knowledge-based services in the shares of SMEs conducting their own R&D. Both sectors rank second and third with values of 16 and 12%. An even lower percentage of other service providers conducts own R&D. R&D is least common in the construction industry.

The shares of businesses conducting their own R&D recovered slightly on the previous year in all sectors with the exception of R&D-intensive manufacturing. The decline in R&D activity in R&D-intensive manufacturing is consistent with the falling share of innovators in these segments. The unfavourable export performance is thus slowing not just current but longer-term innovation activities. Upcoming surveys will need to ascertain whether this is developing into a downward trend even among the pioneers that have been innovators thus far.

Figure 15: Enterprises with own (occasional or continuous) R&D by sector

In per cent



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations

5. Conclusion

Key findings on the development of innovation activity in the SME sector

As already described in the previous innovation report, the OECD's broader innovation definition leads to a higher innovator rate among SMEs, too, than was identified on the basis of the old definition. The findings of past surveys, which are based on the old definition, cannot be directly compared with those of current surveys.

The share of innovators among SMEs currently stands at 40%, unchanged since the previous year's survey. That means unlike investment activity, innovation activity was unable to benefit from the economic recovery in 2022. Among the likeliest reasons for this is that economic expectations already dimmed in the spring of 2022. It is also likely due in part to lingering effects of the pandemic. Innovation activity is currently developing at a subdued rate, particularly in more export-oriented groups of enterprises.

This finding is also confirmed with respect to innovation expenditure in the SME sector, which also remained unchanged on the previous year at just under EUR 34 billion (in current prices). Innovation expenditure among SMEs continues to be heavily concentrated in large enterprises and manufacturing enterprises.

Innovation landscape in Germany is differentiated but focused on R&D

The analysis of the promotional landscape for innovation activity in Germany shows that a differentiated offering of support measures already exists which addresses all phases and all actors in the innovation process.[43] Major gaps in the promotional landscape are hardly identifiable. The scope of promotion varies in individual subsegments, however. Overall, a clear focus on the promotion of R&D is evident. Thus, various potentials for further enhancing the promotional schemes on offer can be identified. Segments that have previously been addressed less strongly and the key hurdles for innovation activity in particular are starting points for economic policy.

Barriers to innovation in the SME sector have risen

Over the past one and a half decades, the impacts of constraints to innovation have grown in almost all segments of the SME sector. This applies to the group of innovators without R&D to a particular degree. What has not changed, however, is that enterprises with R&D activities are the ones most likely to be impacted by constraints.[44] This is probably because they are more likely to encounter barriers and difficulties due to their more ambitious competition strategies and more extensive innovation activities. The federal government's promotional measures therefore focus on the early stages of the innovation process and typically on R&D promotion. An aspect that also supports this promotion is that R&D-based innovation projects can be expected to have the greatest spill-over effects and the most pronounced funding difficulties (resulting from an information imbalance between the innovator and a potential provider of capital).[45]

Capacity and financing-related constraints top the list of innovation barriers in the SME sector. Skilled labour shortages and the high cost of innovating are the most frequent obstacles. However, organisational problems as well as high risks and difficulties in obtaining finance are also mentioned often.[46]

Possible starting points for boosting innovation activity in the SME sector

Target peak segments and the broad business community

Innovation activity in Germany can be stimulated with targeted economic policy support for peak segments and the broad business community. To some extent, this can be understood as a dual strategy. At the peak level, it is important to support businesses' R&D activities. More broadly, the major transformations such as the transition to sustainability, digitalisation and electric mobility, for example, require economic policy to provide direction and coordination, as is currently being pursued by the mission-oriented components of innovation policy.

The need to make further efforts in order to make progress at the peak level is exemplified by the inability in the past years to move closer to reaching the R&D expenditure target of 3.5% of GDP. It is now unlikely that this target is achievable by 2025 as envisaged.

Especially with a view to the innovation activities of small and medium-sized enterprises, it would be a good idea to place a greater focus on the needs of businesses that have no R&D. After all, the trend of the past decades towards fewer innovators without R&D continues. This is also suggested by the fact that even enterprises without R&D can be successful innovators and contribute significantly with their innovations to the diffusion of novelties in the economy. In this way, they make an important contribution to the functioning of the innovation ecosystem as a whole.

Thus, according to analyses performed on the basis of

the innovation survey conducted by the Centre for European Economic Research (ZEW), Mannheim, SMEs without own R&D achieve 34% of SME turnover with product innovations and 42% of cost reductions through process innovations even though, at 20% of innovation spending in the SME sector, they account for a substantially smaller share of innovation expenditure.[47] In addition, scientific studies at company level confirm that SMEs without own R&D hardly lag behind the achievements of enterprises with R&D in terms of their innovation successes.[48]

The following list provides concrete starting points for economic policy measures to increase innovation activity:

Improve funding opportunities
Financing-related barriers present a hurdle for all SMEs. Financing difficulties can be addressed by expanding the level of R&D and innovation promotion in the context of tried and tested promotional measures. The special role of businesses that undertake continuous research activities suggests that comprehensive incentives should be provided to ensure that businesses maintain their existing R&D capacity. Broadly applied measures such as the R&D tax credit that was introduced in 2020 can be effective instruments.[49]

Other promotional financing approaches are low-threshold promotional modules for the target group of innovation-oriented small and medium-sized enterprises without R&D. In the past one and a half decades, these companies in particular were increasingly confronted with constraints to innovation. At the same time, their share as recipients of innovation promotion has dropped at a disproportionately high rate, so that they are now clearly underrepresented compared with their contribution to the SME innovation ecosystem.[50]

The vast portion of the innovation activity of these enterprises is based on experiential skills that are acquired through informal processes of learning and understanding and arise from day-to-day working ('learning by doing, using and interacting').[51] Financial support for these enterprises therefore should not address R&D expenditure but their expenditure on product design and service design.

Ease skilled labour shortages
Easing skilled labour shortages is of particular importance. This applies not just to innovation activity but to the business activity of enterprises in general. According to the most recent KfW-ifo Skilled Labour Barometer, 39% of the businesses surveyed reported that their business activity was disrupted by a shortage of skilled workers.[52]

A wide range of measures can contribute to improving the supply of skilled workers in the German labour market. In the area of school education, for example, these include reducing dropout rates, improving basic competencies by supporting students with learning difficulties and improving basic literacy and numeracy skills. Insufficient social and digital skills, the foundations of which are also laid already at school, constitute major barriers to recruitment for innovative firms as well.

Upskilling through continuing education and training also represents another key starting point. It is important to realise the guiding principle of 'lifelong learning' so that the skills of working-age people keep pace with changing requirements. In order to increase continuing education and training activities, effective learning incentives must be provided in the form of financial support, along with measures for the certification of qualifications and improving the navigation and quality assurance in the confusing market for continuing education and training. At the level of vocational training, existing hurdles must be lowered for small and medium-sized enterprises in particular and they must be made more attractive as businesses that provide training.

In order to reduce the shortage of skilled labour, the existing labour force potential must also be utilised more effectively. In addition to upskilling, there is a need to mobilise the domestic labour force, for example by increasing labour force participation of women and older people, and to view migration as a potential source of skilled labour. The aspects mentioned in this section 'Ease skilled labour shortages' are discussed in greater detail in separate studies by KfW Research on securing the supply of skilled labour.[53]

Build innovation skills
Starting points for economic policy responses include not just increasing the overall availability of skilled labour but developing the specific skills required to carry out innovation projects.[54] In general, four areas of measures can be distinguished here.

First, measures should be introduced that empower businesses to initiate own R&D. To achieve this, it will be necessary to address the specific prerequisites which they must fulfil to carry out innovation projects and initiate R&D. This means acquiring missing technical expertise and market information, as well as developing strategic capabilities and the ability to

cooperate with academia as well as with suppliers and customers. Appropriate measures must generally aim to build scientific and technological competencies.[55] Advisory services and specific offers of funding for initiating R&D can constitute possible measures.

As described above, important sources from which enterprises without own R&D draw their innovative strength are external knowledge and informal learning processes based on, for example, intensive exchange within the enterprise and a corresponding business organisation.[56]

With respect to improving access to external knowledge, integration into regional innovation ecosystems plays an important role because the enterprises referred to in this paper, in particular, often act locally, and these innovation ecosystems differ from one region to another.[57] Promoting regional innovation clusters is therefore an important measure for improving ways in which they internalise external knowledge. In order to address the needs of SMEs without R&D, it is particularly useful to expand cluster promotion below the threshold of clusters of excellence.

In-company processes of learning and understanding can be improved by modifying the work and business organisation[58] and by introducing appropriate management practices. They can be aimed at facilitating knowledge flows within the enterprise, giving workers scope for decision-making and introducing ideas and providing incentives for generating innovations. Not least, they also include a living risk culture that promotes new ideas and accepts failure.[59] One option for supporting these aspects could consist in combining advisory services with financial solutions for their implementation.

Another approach would be to support small and medium-sized enterprises in developing capacities for organising innovation activities. This should benefit enterprises without own R&D in particular. The primary aim here is to increase the availability of staff who are able to design and drive innovation projects. Important aspects here include promoting continuing education schemes around innovation management and more closely integrating innovation aspects into vocational education and training.[60]

Improve strategic skills

Strengthening strategic capabilities can increase the innovative capacity of businesses. Enterprises without an innovation orientation are the main target group here. Many small businesses with well-established but not very innovative business models pay little attention to the aspect of strategic business development because their day-to-day business is their main priority. This often prevents them from seeing the need to focus on innovation and the further development of their business as a whole.[61] It has been shown that businesses that do not pursue an explicit competition strategy are particularly unlikely to innovate or even deal with the topic of innovation activity.

Approaches aimed at improving strategic capabilities include, among other things, awareness-raising campaigns that highlight specific role models and best-practice examples, providing more long-term offers of low-threshold information for SMEs on innovation strategies and innovation management, and continuous monitoring and further development of the quality of advisory services in existing advisory programmes and infrastructures. Helpful approaches can also include explicitly addressing strategic aspects in the context of innovation promotion, such as an innovation audit that can be used in modular form and accounted for as a reimbursable cost.[62]

Annex

The structure of innovative SMEs

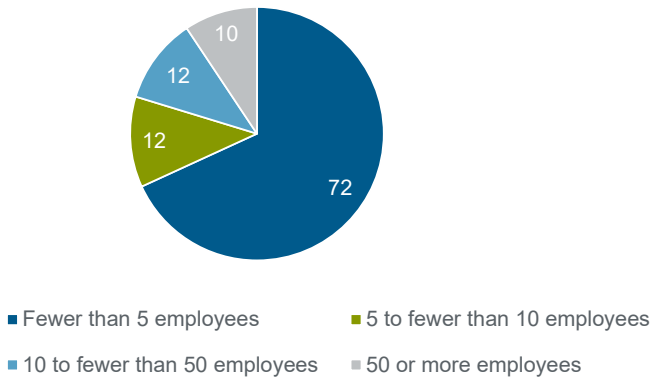
The SME sector, according to KfW's definition, covers all enterprises in Germany whose annual turnover does not exceed EUR 500 million. By this definition, around 3.81 million SMEs exist in Germany. The SME sector thus accounts for 99.95% of all enterprises in Germany. Around 1.5 million of these enterprises are innovators.

The majority of innovative SMEs are small enterprises. The majority of innovative SMEs (1.1 million enterprises, or 72%) have fewer than five employees. This high proportion of small innovators is due to the overall structure of small and medium-sized enterprises. Seventy-nine per cent of SMEs have fewer than five employees. The manufacturing industry accounts for 7% of innovators while the service sector represents 86%.

Seventy-nine per cent of innovative SMEs do not conduct any R&D of their own. A mere 9% research continuously and a further 11% undertook own R&D activities only occasionally in the past three years.

Figure 16: Innovative SMEs by company size

In per cent

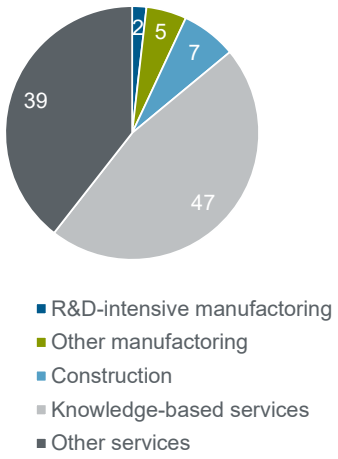


Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations

Figure 17: Innovative SMEs by industry

In per cent

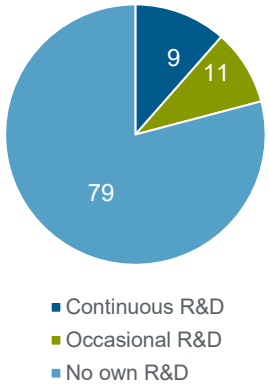


Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations

Figure 18: Innovative SMEs by own R&D activity

In per cent



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations

KfW SME Panel

The KfW SME Panel (KfW-Mittelstandspanel) has been conducted since 2003 as a recurring postal survey of small and medium-sized enterprises in Germany with annual turnover of up to EUR 500 million.

With data based on up to 15,000 companies a year, the KfW SME Panel is the only representative survey of the German SME sector, making it the most important source of data on issues relevant to the SME sector. Due to the fact that it is representative of all SMEs of all sizes and across all branches in Germany, the KfW SME Panel offers projections for even the smallest companies with fewer than five employees. A total of 11,328 SMEs took part in the current wave.

The KfW SME Panel is used as the basis for analyses of long-term structural developments in the SME sector. It gives a representative picture of the current situation and the needs and plans of SMEs in Germany. It focuses on annually recurring information on companies' performance, investment activity, innovation and digitalisation activities and financing structure. This tool provides a unique way of determining quantitative key figures for SMEs such as investment spending, loan demand and equity ratios.

The basic population used for the KfW SME Panel comprises all SMEs in Germany. These include private-sector companies from all sectors of the economy with annual turnover of not more than EUR 500 million. The population does not include the public sector, banks or non-profit organisations. Currently there are no official statistics providing adequate information on the number of SMEs or the number of people they employ. The survey used the German Company Register (Unternehmensregister) and the official employment statistics (Erwerbstätigenrechnung) to determine the current population of SMEs as a starting point.

The KfW SME Panel sample is designed in such a way that it can generate representative, reliable data that are as precise as possible. The sample is split into four groups: type of promotion, branches, firm size as measured by the number of employees, and region. In order to draw conclusions on the basic population based on the sample, the results of the survey are weighted/extrapolated. The four main stratification criteria are used to determine the extrapolation factors. These factors look at the distribution in the net sample (in line with the four group characteristics) in relation to their distribution in the population as a whole. Overall, two extrapolation factors are determined: an unlinked factor for extrapolating qualitative parameters to the number of SMEs in Germany, and a linked factor for extrapolating quantitative parameters to the number of employees in SMEs in Germany.

The survey is conducted by the Marketing & Consumer Intelligence Division of GfK GmbH on behalf of KfW Group. The project received expert advice from the Leibnitz Centre for European Economic Research (ZEW) in Mannheim. The main survey of the 21st wave was conducted in the period from 6 February to 16 June 2023.

Further information can be obtained at **www.kfw-mittelstandspanel.de**.

[1] Cf. Ulku, H. (2004): R&D, Innovation, and Economic Growth: An empirical Analysis, IMF Working Paper 04/195; OECD (2007) (Ed.): Innovation and Growth. Rationale for an Innovation Strategy (https://www.oecd.org/edu/ceri/40908171.pdf), retrieved on 16 June 2016 or Westmore, B. (2013): R&D, Patenting and Growth: The Role of Public Policy, OECD Economics Department Working Papers, No. 1047, OECD Publishing, Paris or Dachs, B., Hud, M., Koehler, C., and Peters, B. (2017): Innovation, Creative Destruction and Structural Chance: Firm-level Evidence from European Countries, Industry and Innovation 2(4): 346–381.

[2] Cf. Bravo-Biosca, A.; Marston, L.; Mettler, A.; Mulgan, G. and Westlake, S. (2013), Plan I – Innovation for Europe, Nesta and the Lisbon Council.

[3] Cf. Zimmermann, V. (2022), Investitionen in immaterielles Kapital steigern die Produktivität (Investment in intangible capital enhances productivity – in German only), Focus on Economics No. 408, KfW Research, Zimmermann, V. (2021), Innovationen steigern Wachstum und Produktivität und verbessern die Qualifikationsstruktur der Beschäftigten in mittelständischen Unternehmen (Innovation boosts growth and productivity and improves the structure of workforce qualifications in small and medium-sized enterprises – in German), Focus on Economics No. 361, KfW Research; Zimmermann, V. (2017), Success factors of high-growth enterprises, Focus on Economics No. 177, KfW Research. Zimmermann, V. (2015): What are the hallmarks of consistently successful businesses? Focus on Economics No. 113, KfW Research.
Zimmermann, V. (2015): KfW SME Innovation Report 2014: Standstill in Europe is slowing down innovation, KfW Research,
Zimmermann, V. (2014): Innovation and Employment. Die Beschäftigungswirkung verschiedener Arten von Innovationen in expandierenden und schrumpfenden mittelständischen Unternehmen (*The employment effect of different types of innovation in expanding and contracting SMEs*), Journal of Business Economics, ZfB-Special Issue 4/2013 (in German): p. 131–149,
Kritikos, A. S., Hafenstein, M. and Schiersch, A. (2017): Auch kleinste Betriebe stoßen erfolgreich Innovationen an, sie tun es nur seltener (*Micro-businesses, too, stimulate innovation successfully, they just do it less often* – our title translation, in German), DIW Wochenbericht 27, p. 755–761.

[4] Cf. Aghion, P., Akcigit, U., Hyytinen, A. and Toivanen, O. (2018): On the returns to invention within firms: Evidence from Finland. The American Economic Association Papers and Proceedings 108: 208–212.

[5] Cf. Dauth et al. (2017): German Robots – The Impact of Industrial Robots on Workers, IAB Discussion Paper 30/2017.

[6] Cf. Kulicke, M.; Beckert, B. and Stolz, C. (2023): Studie zum Förderfeld „Digitalisierung und Innovation" im Auftrag der Kreditanstalt für Wiederaufbau (KfW) (*Study on the promotional area of 'Digitalisation and innovation' on behalf of KfW* – our title translation, in German), Fraunhofer Institute for Systems and Innovation Research ISI, and Zimmermann, V. (2023): Wo steht Deutschland bei Innovation und Digitalisierung im internationalen Vergleich? (*Where does Germany stand in innovation and digitalisation in an international comparison?* – in German only), Focus on Economics No. 412; KfW Research.

[7] Cf. Zimmermann, V. (2022): Zimmermann, V. (2022), Die Entwicklung der FuE-Ausgaben in Deutschland im internationalen Vergleich (The development of R&D expenditure in Germany in international comparison – in German), Focus on Economics No. 404, KfW Research and Rammer, C. and Trunschke, M. (2022): Studie zur Entwicklung der Forschungs- und Entwicklungsausgaben in Deutschland im internationalen Vergleich (*Study on the development of research and development expenditure in Germany in an international comparison* – our title translation, in German), Study commissioned by KfW Group, Leibniz Centre for European Economic Research.

[8] Cf. Zimmerman, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, Study commissioned by KfW Group, Leibniz Centre for European Economic Research.

[9] Cf. OECD and Eurostat (2018) (publishers), Oslo Manual 2018. Guidelines for collecting, reporting and using innovation data. OECD Publishing.

[10] Cf. Zimmermann, V. and Thomä, J. (2019), Interactive learning or R&D: How do small and medium-sized enterprises generate innovations?. Focus on Economics No. 264, KfW Research or Jensen, M. B., Johnson, B., Lorenz, E. and Lundvall, B. A. (2007): Forms of knowledge and modes of innovation. Research Policy 36(5): 680–693.

[11] The KfW SME Panel captures whether an enterprise has introduced innovations for a three-year period using the method commonly applied across Europe.

[12] Cf. OECD and Eurostat (2018) (publishers), Oslo Manual 2018. Guidelines for collecting, reporting and using innovation data. OECD Publishing.

[13] Cf. Schwartz, M., and Gerstenberger, J. (2023): KfW SME Panel 2023. SMEs' resilience is being put to the test. So far, they have come away with few bruises, but now they are increasingly nervous, KfW Research.

[14] Cf. Zimmermann, V. (2020): Innovation during the coronavirus crisis: necessity is the mother of invention, Focus on Economics No. 295, KfW Research; Zimmermann, V. (2021): Coronavirus crisis is hampering innovation, digitalisation sees mixed trend, Focus on Economics No. 312, KfW Research and Zimmermann, V. (2021): KfW SME Innovation Report 2020: Coronavirus crisis is slowing down innovation, KfW Research.

[15] Cf. Bloom, N. et al. (2007): Uncertainty and Investment Dynamics, Review of Economic Studies, 74, 391–415.

[16] Cf. Trunschke, M. et al. (2023): Pandemic Effects: Do Innovation Activities of Firms Suffer from Long-COVID?, ZEW Discussion Paper No. 23-014.

[17] Cf. Scheuermeyer, P. (2023): SME business sentiment on the path to recovery, KfW-ifo SME Barometer: November 2023, KfW Research.

[18] Cf. Schwartz, M., and Gerstenberger, J. (2023): KfW SME Panel 2023.. Volume of tables, Table 4, p. 3.

[19] Cf. Zimmermann, V. (2018): Determinants of digitalisation and innovation behaviour in the SME sector, Focus on Economics No. 236, KfW Research, Zimmermann, V. (2017): SME innovations: Seven reasons for the decline in the share of innovators. Focus on Economics No. 185, KfW Research; Zimmermann, V. (2017), Research and development (R&D) in SMEs: Internal funding capacity determines scope of R&D expenditure, Focus on Economics No. 190, And Poschen, K. and Zimmermann, V (2014): Falling sales expectations curb SME innovation activity in Germany, Economics in Brief No. 58, KfW Economic Research.

[20] Cf. Zimmermann, V. (2010): Innovation und Konjunktur (Innovation and economic activity), Points of View No. 10, June 2010, KfW Economic Research.

[21] Cf. Zimmerman, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, Study commissioned by KfW Group.

[22] The number of employees is calculated including the active owners but excluding trainees and apprentices. Two part-time employees are counted as one full-time employee.

[23] Cf. Crepon, B. et al. (1998): Research, Innovation and Productivity: An Econometric Analysis at the Firm Level; economics of Innovation and New technology 7(2): 115–158 or Baptista, R. (2000): Do innovations Diffuse Faster with Geographical Clusters? International Journal of Industrial Organisation 15: 515–535.

[24] Cf. Galbraith, J. K. (1952): American Capitalism. The Concept of Countervailing Power. Boston, Hougthon Mifflin, p. 92, Cohen, W. M., Levin, R. C. and Mowery, D. (1987): Firm Size and R&D Intensity. A Re-Examination. Journal of Industrial Economics 35, p. 543–563 or Cohen, W. S. and Klepper, S. (1996): Firm Size and the Nature of Innovation within Industries: The Case of Process and Product R&D. Review of Economics and Statistics 78(2), p. 232–243.

[25] Cf. Zimmermann, V. and Köhler-Geib, F. (2023): Impact of the COVID-19 Pandemic on Different Groups of SMEs in Germany and Their Recovery, Intereconomics, forthcoming.

[26] Cf. Zimmermann, V. and Köhler-Geib, F. (2023): Impact of the COVID-19 Pandemic on Different Groups of SMEs in Germany and Their Recovery, Intereconomics, forthcoming.

[27] Cf. Zimmermann, V. and Köhler-Geib, F. (2023): Impact of the COVID-19 Pandemic on Different Groups of SMEs in Germany and Their Recovery, Intereconomics, forthcoming and Abel-Koch, J. (2023): KfW Internationalisation Report 2023. Many SMEs currently perform better than their foreign competitors but see need for action to secure their future competitiveness, KfW Research.

[28] Cf. Abel-Koch, J. (2023): KfW Internationalisation Report 2023. Many SMEs currently perform better than their foreign competitors but see need for action to secure their future competitiveness, KfW Research.

[29] Cf. Schlegelmilch, B. (1988): Der Zusammenhang zwischen Innovationsneigung und Exportleistung (*The correlation between innovation propensity and export performance* – our title translation, in German). Ergebnisse einer empirischen Untersuchung in der deutschen Maschinenbauindustrie (*Results of an empiric survey of the German engineering industry* – our title translation, in German), in: Zeitschrift für betriebswirtschaftliche Forschung 50(3), p. 227–269; Lachenmaier, S. and Wößmann, L. (2006), Does Innovation Cause Exports? Evidence from Exogenous Innovation Impulses and Obstacles using German Micro Data, Oxford Economic Papers 58(2), p. 317–350; Greenaway, D. and Kneller, R. (2007): Firm heterogeneity, exporting and foreign direct investment, The Economic Journal 117(517), p. F134 – F161, and Wagner, J. (2007): Exports and productivity: A survey of the evidence from firm-level data, World Economy 30(1), p. 60–82.

[30] Cf. Andersson, M. and Lööf, H. (2009): Learning by Exporting Revisited – the role of intensity and persistence, in: Scandinavian Journal of Economics 111(4), 893 – 913 and Harris, R and Li, Q.C. (2009): Exporting, R&D, and Absorptive Capacity in UK Establishments, Oxford Economic Papers 61, p. 74-103.

[31] Cf. Zimmermann, V. and Köhler-Geib, F. (2023): Impact of the COVID-19 Pandemic on Different Groups of SMEs in Germany and Their Recovery, Intereconomics 58(6), p. 333-341.

[32] Cf. Zimmermann, V. (2020): Innovation during the coronavirus crisis: necessity is the mother of invention, Focus on Economics No. 295, KfW Research; Zimmermann, V. (2021): SMEs delay innovation during the coronavirus crisis, digitalisation shows a mixed trend, Focus on Economics No. 312, KfW Research and Zimmermann, V. (2021): KfW SME Innovation Report 2020: Coronavirus crisis is slowing down innovation, KfW Research.

[33] Cf. Zimmermann, V. (2020): Innovation during the coronavirus crisis: necessity is the mother of invention, Focus on Economics No. 295, KfW Research as well as Focus on Economics publications from 2020 and Zimmermann, V. (2021), KfW SME Innovation Report 2020: Coronavirus crisis is slowing down innovation, KfW Research.

[34] Cf. Zimmermann, V. (2021): SMEs delay innovation during the coronavirus crisis, digitalisation shows a mixed trend, Focus on Economics No. 312, KfW Research and Zimmermann, V. (2022): KfW SME Digitalisation Report 2021. Corona pandemic triggers digitalisation push but digitalisation is still not a matter of course, KfW Research.

[35] Specifically, this includes expenditure on internal and external research and development (R&D), innovation-related expenditure on machinery, equipment, software and external knowledge (e.g. patents and licenses). It also includes expenditure on product design, construction, service design and preparation for the manufacture and sale of innovations. Expenditure on training conducted in the context of innovations and their introduction into the market is included as well.

[36] The deflation of innovation expenditure is done with a composite deflator made up 25% of the variation in the prices for fixed capital formation in machinery and equipment and 75% of the variation in the prices of other machinery and equipment as reported by the Federal Statistical Office (2023) (ed.) Fachserie 18 Reihe 1.4, Blatt 2.3.11. This deflator can be considered an approximation to the inflation rate of innovation expenditure, because according to calculations made on the basis of the innovation survey conducted by the Centre for European Economic Research in Mannheim, innovation expenditure is composed 25% of physical investments and other machinery and equipment comprises, among other things, expenditure on intellectual property such as research and development.

[37] With reference to total investment spending on new and used goods. Cf. Schwartz, M., and Gerstenberger, J. (2023): KfW SME Panel 2023. Volume of tables, Table 6, p. 5.

[38] The deflator for investment expenditure was used in analogy to the deflator in Schwartz, M., and Gerstenberger, J. (2023): KfW SME Panel 2023. SMEs' resilience is being put to the test. So far, they have come away with few bruises, but now they are increasingly nervous, KfW Research.

[39] Cf. OECD (2015) (publisher): Frascati Manual 2015. Guidelines for collecting and reporting data on research and experimental development.

[40] Cf. Zimmermann, V. And Thomä, J.: (2019), Interactive learning or R&D: How do small and medium-sized enterprises generate innovations? Focus on Economics No. 264, KfW Research or Jensen, M. B., Johnson, B., Lorenz, E. and Lundvall, B. A. (2007): Forms of knowledge and modes of innovation. Research Policy 36(5): 680–693 and Thomä, J. and Zimmermann, V. (2020), Interactive learning — The key to innovation in non-R&D-intensive SMEs? A cluster analysis approach, Journal of Small Business Management 58(4):747–776.

[41] Cf. Zimmermann, V. (2019): KfW SME Innovation Report 2018. Innovator rate has fallen again, KfW Research.

[42] Cf. Zimmermann, V. (2017): KfW SME Innovation Report 2016: Innovation is concentrated in increasingly fewer enterprises, KfW Research.

[43] Cf. Kulicke, M.; Beckert, B. and Stolz, C. (2023): Studie zum Förderfeld „Digitalisierung und Innovation" im Auftrag der Kreditanstalt für Wiederaufbau (KfW) (*Study on the promotional area of 'Digitalisation and innovation' on behalf of KfW* – our title translation, in German), Fraunhofer Institute for Systems and Innovation Research ISI, and Zimmermann, V. (2023): Wo steht Deutschland bei Innovation und Digitalisierung im internationalen Vergleich? (*Where does Germany stand in innovation and digitalisation in an international comparison?* – in German only), Focus on Economics No. 412; KfW Research.

[44] Cf. Zimmermann, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, Study by the Centre for European Economic Research on behalf of KfW Group.

[45] Cf. Zimmermann, V. (2022), Innovationsfinanzierung im Mittelstand: Selbst die externe Finanzierung wenig anspruchsvoller Vorhaben ist schwierig (Innovation finance in SMEs: even the external financing of less ambitious projects is difficult – in German); Focus on Economics No. 397, KfW Research.

[46] Cf. Zimmermann, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, Study by the Centre for European Economic Research on behalf of KfW Group.

[47] Cf. Zimmermann, V. (2022): Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, study commissioned by KfW Group.

[48] Cf. Thomä, J. and Zimmermann, V. (2020), Interactive learning — The key to innovation in non-R&D-intensive SMEs? A cluster analysis approach, Journal of Small Business Management 58(4):747-776 and Zimmermann, V. and Thomä, J.: (2019), Interactive learning or R&D: How do small and medium-sized enterprises generate innovations?. Focus on Economics No. 264, KfW Research; Zimmermann, V. and Thomä, J. (2019), Business performance of different types of small and medium-sized innovators, Focus on Economics No. 265, or Rammer, C., Czarnitzki, D. and Spielkamp, A. (2009): Innovation success of non-R&D performers: substituting technology by management in SMEs. Small Business Economics 33(1), p. 35–58.

[49] Cf. Dechezleprêtre, A. et al. (2023): Do Tax Incentives Increase Firm Innovation? An RD Design for R&D, Patents, and Spillovers, American Economic Journal: Economic Policy 15(4):486-521; Guceri, I. and Liu, L. (2019): Effectiveness of fiscal incentives for R&D: quasi experimental evidence. American Economic Journal: Economic Policy 11(1):266-291, Rammer, C. (2021): Ansätze zur Verbesserung der administrativen Umsetzung der Forschungszulage, Ergebnisse einer Befragung des VDMA (*Approaches to improving the administrative implementation of the research grant, findings of a survey by the VDMA* – our title translation, in German), Leibniz Centre for European Economic Research, and Rammer, C. (2023): Erfahrungen mit der Umsetzung der Forschungszulage im Maschinen- und Anlagenbau, Ergebnisse einer Befragung des VDMA (*Experiences with implementing the research grant in engineering and plant production, results of a survey by VDMA* – our title translation, in German), Leibniz Centre for European Economic Research.
[50] Cf. Zimmermann, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, study by the Centre for European Economic Research on behalf of KfW Group.
[51] Cf. Jensen, M. B., Johnson, B., Lorenz, E. and Lundvall, B. A. (2007): Forms of knowledge and modes of innovation. Research Policy 36(5): 680–693.

[52] Cf. Müller, M. (2023): Weak business cycle reduces skilled labour shortages – challenge remains, KfW-ifo Skilled Labour Barometer, December 2023, KfW Research.

[53] Cf. Zimmermann (2024): High skills requirements make hiring a challenge, especially for innovative enterprises, Focus on Economics, forthcoming; Zimmermann, V. (2023): Mittelständische Unternehmen setzen auf Qualifizierung und allgemeine personalpolitische Maßnahmen zur Sicherung des Fachkräftebedarfs (SMEs focus on training and general HR policy measures to meet their skilled labour needs – in German only) Focus on Economics No. 445, KfW Research. Zimmermann, V. (2023): Fehlende Digitalkompetenzen erschweren die Besetzung offener Stellen in digital aktiven Unternehmen (Shortage of digital skills makes it difficult for digitally active firms to fill vacancies – in German only), Focus on Economics No. 420, KfW Research, and Müller, M. (2023): Skills shortage marks a turning point: The times of guaranteed growth are over, Focus on Economics No. 415, KfW Research.

[54] Cf. Zimmermann, V. and Thomä J. (2016), SMEs face a wide range of barriers to innovation – support policy needs to be broad-based, Focus on Economics No. 130, KfW Research.

[55] Cf. Zimmermann, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, study commissioned by KfW Group.

[56] Cf. Thomä, J. and Zimmermann, V. (2020), Interactive learning — The key to innovation in non-R&D-intensive SMEs? A cluster analysis approach, Journal of Small Business Management 58(4): 747-776 and Zimmermann, V. and Thomä, J. (2019), Interactive learning or R&D: How do small and medium-sized enterprises generate innovations?. Focus on Economics No. 264, KfW Research.

[57] Cf. Thomä, J. and Bizer, K. (2021), Governance mittelständischer Innovationstätigkeit – Implikationen des Doing-Using-Interacting-Modus (*Governance of SME innovation activity – Implications of the Doing-Using-Interacting Mode* – our title translation, in German), Perspektiven der Wirtschaftspolitik 22(4), p. 350–369.

[58] Cf. Totterdill, P. (2015): Closing the Gap: The Fifth Element and Workplace Innovation, European Journal of Workplace Innovation, 1(1): 55–74.

[59] Cf. Thomä, J. and Zimmermann, V. (2020), Interactive learning — The key to innovation in non-R&D-intensive SMEs? A cluster analysis approach, Journal of Small Business Management 58(4): 747-776 and Zimmermann, V. and Thomä, J.: (2019), Interactive learning or R&D: How do small and medium-sized enterprises generate innovations?. Focus on Economics No. 264, KfW Research.

[60] Cf. Zimmermann, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, Study by the Centre for European Economic Research on behalf of KfW Group.

[61] Cf. Astor, M. et al. (2016): Innovativer Mittelstand 2025 – Herausforderungen, Trends und Handlungsempfehlungen für Wirtschaft und Politik (*Innovative SMEs in 2025 – challenges, trends and recommendations for action for business and policy-makers* – our title translation, in German), Berlin: Federal Ministry for Economic Affairs and Energy.

[62] Cf. Zimmermann, V. (2022), Types of SMEs in the innovation system: activities, constraints and successes, Focus on Economics No. 394, KfW Research, and Rammer, C. et al. (2022): Drivers and Barriers for Innovation in the German SME sector, Study by the Centre for European Economic Research on behalf of KfW Group.