

KfW Research

# KfW SME Innovation Report 2020 Coronavirus crisis is slowing down innovation among SMEs



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#### Imprint

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The share of innovators among SMEs has been declining for around one and a half decades now. Since reaching its peak level during the 2004–2006 survey period, the share of SME innovators dropped by nearly half (-49%) up to 2017–2019. By contrast, aggregate expenditure on innovation and R&D increased almost continuously across the economy during the same period.<sup>1</sup> That means innovation activity across the broad economy is on the decline, while innovation is concentrated in ever fewer and mainly large enterprises.

Innovation activity in SMEs continued to decline during the coronavirus crisis as well, as 27% of SMEs innovated less during this time than in 2019. By contrast, only 12% of SMEs stepped up their innovation activity. In particular, businesses with fewer than five employees scaled back their innovation efforts (balance between increase and decrease in innovation: -17 points compared with -1 point in SMEs with 50 or more employees). Moreover, innovation is being reduced precisely by those companies that were hit hard by the crisis and are suffering severe liquidity shortages (balance: -34 points compared with -8 points in enterprises with sufficient liquidity) and by those that expect the crisis to continue for a long time (balance: -31 points). This shows that financing difficulties in the crisis play a significant role in the decline in innovation activity. On the other hand, SMEs that already successfully innovated before the coronavirus pandemic are less likely to decrease innovation activity, with -4 points on balance, than companies that do not innovate (balance: -21 points).

The importance of financing difficulties as a barrier to innovation is likely to continue gaining importance especially after the acute crisis phase has been overcome.

Given the tense liquidity situation and higher debt levels of companies following the crisis, the trade-off between the desire for higher crisis resilience and the need for more investment in future competitiveness is becoming more difficult to manage. Innovation policy will therefore have to provide stronger financial incentives to prevent innovation projects from taking a back seat more often than they already did before the crisis.

Furthermore, especially across the broad SME sector – among those companies that conduct no research and development (R&D) of their own – the skills shortage in combination with a lack of technical expertise and market information is putting the brakes on innovation activity. Promotional measures aimed at building these companies' innovation capacity must therefore be expanded. This can start with measures aimed at strengthening basic and advanced training and the capacity to absorb external knowledge, together with support for organisational innovations which strengthen the innovative capacity of these companies as a whole - i.e. irrespective of whether they conduct any specific innovation projects – by improving work management and company organisation.

### 1. Introduction

### Innovation is a driver of growth and prosperity

From a macroeconomic perspective, innovation drives economic and productivity growth, speeding up the structural transformation.<sup>2</sup> In developed economies it is therefore regarded as a guarantor for safeguarding and increasing the achieved prosperity.<sup>3</sup> As a highly developed country with few natural resources, Germany must therefore secure or, where necessary, expand its technological lead in key business areas. In addition, innovation contributes to addressing social challenges such as climate change, health care and demographic change.

From a business perspective, innovating is an important mechanism 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' head-count, turnover, returns and productivity.<sup>4</sup> This applies not just to enterprises on the cutting edge of technolog-ical progress but also to those that innovate without conducting any R&D of their own.<sup>5</sup> Thus, the diffusion of new technologies across the economy plays an important role as well. This is also because it secures the competitiveness of the economy as a whole. Work-

ers also benefit from their employers' innovations, as innovative companies pay higher wages.<sup>6</sup>

#### Innovation is more than research and development

Thus, innovations are not just novelties based on research and development (R&D), such as special devices for the measurement of airborne particles or specialised machines for the manufacture of emulsions such as ointments and creams, for example. Small and medium-sized enterprises, in particular, often develop innovations out of the normal production process or in cooperation with customers and suppliers without any research activity ('learning by doing, using and interacting').<sup>7</sup> Examples of such an innovation, which can be quite complex, are a new, mobile and easy-to-use device for lifting loads on construction sites, or the further development of filter equipment for the food and pharmaceutical industry. Innovating also means adapting products and services to specific customer requests or introducing new services such as a delivery service. A new or improved product (including the related service) or process is regarded as an innovation when it is new or significantly improved in essential aspects for the enterprise adopting it.8

### 2. Innovation activity during the coronavirus crisis

### After initial coronavirus-induced surge, innovation is declining again

At the beginning of the coronavirus pandemic, innovation surged – as did digitalisation. Within a short period of time after the outbreak of the pandemic, many enterprises introduced process innovations in Germany. A slightly smaller portion also responded with new or improved products as well as with business model innovations.<sup>9</sup> It was crucial for businesses to respond flexibly to declines in demand and supply shortages and other pandemic requirements. How important the response to the crisis situation was for these innovation activities to be carried out at the start of the crisis is evident from the fact that the most active innovators were businesses which suffered high turnover losses.

### Figure 1: Development of innovation activities in the course of the coronavirus pandemic



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel 2020, 3rd to 5th supplementary survey, own calculations

In order to examine how innovation activity has evolved in the further course of the pandemic, KfW Research conducted supplementary surveys under the KfW SME Panel (see box 'Supplementary coronavirus surveys under the KfW SME Panel').

The key finding of these surveys, however, was that this initial innovation surge did not continue in the further course of the pandemic. Already in September 2020, more SMEs (25%) reported a reduction (or even termination) of their innovation activities than those reporting an increase, resumption or initiation (10%) compared with the pre-coronavirus situation (Figure 1). The subsequent supplementary surveys confirmed this trend. The recent survey of May 2021 revealed that 27% of SMEs reduced or terminated their innovation activities entirely in the course of the crisis. By contrast, only 12% of SMEs expanded, resumed or initiated innovation activities. One fifth of businesses continued their innovation activity unchanged up to May 2021, while 40% were still not innovating at all. This finding was supported by the ZEW 2020 Innovation Survey conducted in spring. In it, small and medium-sized enterprises in particular reported plans to reduce their innovation expenditure in the years 2020 and 2021.<sup>10</sup>

### SMEs that were hit hard by the crisis reduced their innovation activities

An analysis of how innovation activity has changed based on the severity of the crisis impact shows that the share of businesses that reduced their innovation activities during the crisis rose significantly the harder they were affected. Thus, 65% of SMEs whose survival has been threatened by the crisis have cut back their innovation activities. This proportion is a mere 10% among enterprises that have not been affected, or only minimally (Figure 2).





Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel 2020, 5th supplementary survey (May 2021), own calculations

To be sure, the share of SMEs that expanded their innovation activities is slightly higher in the middle group – 'severely' affected enterprises – than in the other groups. However, the balance of enterprises expanding minus enterprises reducing innovation activities shows that the more SMEs are affected by the crisis, the more they scale back their activities. Thus, among the SMEs hardly or moderately affected by the coronavirus crisis, the share of those that have expanded and those that have cut back their innovation activities is the same (10% each). Among those hit hard, the balance is -15 points, while among those enterprises whose survival has been under threat the proportion reducing innovation clearly predominates, at -54 points on balance.

One likely reason is that enterprises are reluctant to bring product innovations to market in a weak business cycle. After all, product innovations tend to perform poorly in the market in such phases.<sup>11</sup> It is also possible that work under pandemic conditions hampers actual innovation activity, for example because infection control measures make it difficult to work in the company and with business partners (due to hygiene requirements and home working, for example).

## Liquidity shortage has put the brakes on innovation activity, ...

The more important reason, however, is likely that the more severely they have been affected by the crisis, the more businesses lack the financial resources they need to carry out comprehensive innovation activities. After all, turnover losses have caused liquidity bottlenecks in the SME sector.<sup>12</sup>

Thus, assuming the current situation continues as it was at the time of the survey, SMEs that will run out of cash within two months at the latest are more likely to reduce their innovation activities, at -43 points on balance. Among those that have enough cash to survive another year or longer, that balance is a mere -8 and -9 points (Figure 3).

## Figure 3: Development of innovation activities by cash reach

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel 2020, 5th supplementary survey (May 2021), own calculations

Supplementary coronavirus survey to the KfW SME Panel

The supplementary surveys to the KfW SME Panel which we evaluate here were conducted online from 1 to 14 September 2020, from 12 to 22 January 2021 and from 3 to 14 May 2021. They addressed the current impact of the coronavirus crisis. All enterprises that participate in the KfW SME Panel and had provided a valid email address were surveyed. As the supplementary survey was linked to the main database of the KfW SME Panel, <sup>13</sup> the findings can be extrapolated to the total population of SMEs.

With respect to innovation activities, businesses were presented with a text explaining what is to be understood by the term innovation and with the OECD's new definition of innovation, which includes marketing and organisational innovation. The development of innovation activities was then surveyed as followed:

Has the coronavirus crisis had any effects on your innovation activity?

Respondents could choose from the following replies:

- We terminated our innovation activities completely,
- We scaled back our innovation activities compared with the pre-coronavirus situation,
- We continued our innovation activities nearly unchanged from the pre-coronavirus situation,
- We increased our innovation activities compared with the pre-coronavirus situation,
- We resumed or started our innovation activities in the course of the coronavirus crisis after conducting no digitalisation activities prior to the coronavirus crisis.

For the analysis, the possible responses 'terminated completely' and 'scaled back' as well as 'resumed' and 'increased' were combined for the sake of clarity.

With regard to the length of time enterprises can ride out with their existing cash, it has also been shown that the group in the medium-impact range is most likely to expand their innovation activities. However, in this group the share of businesses that have cut back their innovation activities is already significantly higher, at 28%, than in the group of enterprises that can survive even longer with their current liquidity.

Other surveys have also confirmed the great impor-

tance of having internal resources to carry out innovation activities under the coronavirus pandemic. According to the ZEW Survey on Innovation, lack of internal resources is far and away the main reason for restricting innovation activities in the sectors it analysed.<sup>14</sup>

#### ... as have expectations of a prolonged crisis

These findings are confirmed by the fact that on balance, SMEs tend to wind down their innovation activities the longer they expect the crisis to drag on. The difficult financial situation is also likely to be the primary cause for this. Businesses expect turnover to remain low and their equity situation therefore to remain tight, so they try to stretch their internal funds to make them last a longer period of time.

Thus, the supplementary survey of January 2021 revealed that the share of SMEs scaling back their innovation activities grows significantly from 5 to 46% the longer they expect the crisis to last (Figure 4). The share of enterprises that continue innovating also declines at the same time. To be sure, the proportion of SMEs that step up their innovation efforts also increases moderately the longer the crisis continues. But this increase is not nearly enough to equal or exceed the share of SMEs slowing down innovation efforts.

### Figure 4: Development of innovation activities depending on how long a business believes it will take for the impact of the pandemic to be overcome





Note: Values extrapolated from the number of employees.

Source: KfW SME Panel 2020, 4th supplementary survey (January 2021), own calculations

### Large SMEs are often trailblazers, even under coronavirus conditions

Innovation activities have developed in significantly different ways between large and small SMEs, as was the case before the coronavirus pandemic. With increasing company size, the shares of companies scaling back their activities, in particular, dropped. At the same time, the shares of enterprises that continue innovating rise while the share of those without any activities fall (Figure 5). Large SMEs, in particular, expanded their innovation activities by 20% on the pre-coronavirus level. The share of enterprises that reduced their innovation activities fell from 29% in the group of small businesses with fewer than five employees to 21% in SMEs with 50 or more employees.

## Figure 5: Development of innovation activities by enterprise size



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel 2020, 5th supplementary survey (May 2021), own calculations

Besides the general reasons small businesses innovate less (see chapter 3), this observation probably reflects the fact that small businesses in particular often have fewer financial resources and the impact of the crisis is therefore more likely to be an existential threat for them than for larger SMEs.<sup>15</sup>

### Figure 6: Development of innovation activities by economic sector



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel 2020, 5th supplementary survey (May 2021), own calculations

From a sectoral perspective, on balance innovation activities are most likely to be reduced in the services sector, where the balance of businesses expanding minus businesses reducing innovation activities is -19 points. In manufacturing, a sector that is a very active innovator in normal times, businesses reduce their innovation activities at a similar rate on balance (-14 points) (Figure 6). In trade, for which the coronavirus crisis is the biggest existential threat, that balance is -4 points. The reason for the less pronounced drop is that retail businesses are generally less likely to innovate than businesses in the previously mentioned sectors. At 47%, the share of enterprises that continue without innovating is significantly higher here than in manufacturing and in services. In the construction sector, which generally innovates little and is relatively unaffected by the pandemic, the balance of businesses that innovate more minus those that innovate less is in a similar range (balance: -7 points).

### Innovative SMEs also respond to crises by innovating more

Finally, enterprises that have successfully innovated in the past years are also more likely to step up their innovation efforts under coronavirus conditions than those that have not. At 24%, the share of enterprises that have expanded their innovation activities among those that innovated previously is nearly 3.5 times higher than among non-innovators (Figure 7). Overall, among those that already innovated in the past, the share of enterprises that have expanded and cut back innovation activities is nearly equal (balance -3 points). Among SMEs that did not innovate before the crisis, however, this balance is a clearly more negative -21 points.

## Figure 7: Development of innovation activities by successful past innovation activity



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel 2020, 5th supplementary survey (May 2021), own calculations

The capacity and willingness to respond to changes in the market situation by innovating are therefore company-specific. They are closely tied to successful past innovation activity. The capacity to innovate thus also makes these businesses resilient in acute crises<sup>16</sup> and thus helps regain lost ground on rivals after the crisis by being more competitive.

### Coronavirus crisis is hampering innovation activity

These analyses demonstrate that after an initial innovation surge, the coronavirus crisis is clearly putting the brakes on innovation activity. The more companies are affected by the crisis and the tighter their liquidity situation is, the more they cut back their innovation efforts. Thus, the impact of the crisis on innovation is fundamentally different from its impact on digitalisation activity, where an increase was identified on balance.<sup>17</sup> The main reason it has slowed innovation activity is likely the fact that, for one thing, the crisis led to a shortage of cash needed to finance innovation projects. For another, many businesses are likely to have focused more intensely on digitalisation precisely during the crisis because under the pandemic conditions, digitalisation measures were able to make a particular contribution to responding swiftly to declines in demand and supply bottlenecks, complying with distancing requirements and ensuring visibility for customers and cooperation partners.18

### 3. Development of innovation activity before the coronavirus crisis

#### Share of innovators is declining in the long term

Under the new OECD definition, the share of innovators in Germany's SME sector is 22% (Figure 8).<sup>19</sup> The innovator rate measures the share of enterprises that have introduced at least one innovation in the past three years. Unlike in last year's survey, the innovator rate now also includes companies with marketing and organisational innovations (box: New OECD innovation definition). A direct comparison with the results of the previous period (2016-2018: 19%) is therefore not possible. But despite the expanded definition, the current innovator rate is even lower than in the period before that (2015–2017: 23%). Thus, there are currently just under 840,000 innovative small and medium-sized enterprises. In 2019 the business cycle had already weakened slightly before the coronavirus pandemic struck. That is likely to have slowed innovation activity compared with previous years.<sup>20</sup> At the same time, the definition of innovation has been expanded. On balance, a slight increase in the share of innovators on the previous period can be identified.

#### Figure 8: Development of innovators among SMEs

in per cent



Note: Figures extrapolated to the number of enterprises; with new OECD definition from 2017/2019: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

In the long term, however, the trend is pointing downwards despite the expansion of the definition of innovation. With a share of 43%, the share of innovators in the 2004/2006 period was nearly twice as high as before the coronavirus crisis even with the narrower, old definition.

#### New OECD innovation definition

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

The OECD changed the definition of innovation in 2018.<sup>21</sup> 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.

This change in the definition was taken into account for the first time in the current survey of the KfW SME Panel for the year 2019 and in the special surveys conducted during the year on the development of innovation activities during the coronavirus crisis. The expansion of the definition of innovation means that more activities are regarded as innovations, so that typically – for example in an unchanged economic environment – the share of innovators measured is higher than before the definition was changed.

Compared with the peak level of 2004/2006, the innovator rate dropped steeply particularly in the second half of the 2000s. It initially surged again after the economic and financial crisis. After that, however, the decline continued, if at a slower pace. In the last years before the definition of innovation was changed, the decline in the innovator rate accelerated again, however.

With regard to the distinction between product and process innovators, the corresponding shares are each 16% (Figure 9). In other words, just under 600,000 SMEs brought new or improved products to market in the period under review, while just as many modernised their manufacturing processes. It is not surprising that the share of both product and process innovators is higher than in the previous survey. After all, the expansion of the definition applies to both types of innovation: Under the new definition, most of the previous marketing and organisational innovations are now counted as process innovations. Changes in design, however, which used to be regarded as marketing innovations, are now classified as product innovations. A long-term comparison shows a declining share of both product and process innovators. Up until the 2016–2018 period, the share of product innovators decreased by around two thirds of its highest level in the 2004–2006 period. By comparison, the share of process innovators fell less sharply during this period, falling by around one third.

## Figure 9: Development of SME product and process innovators

In per cent



Note: Figures extrapolated to the number of enterprises; with new OECD definition from 2017/2019: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

### Rate of innovators is on a long-term decline among businesses of all size classes...

With the expansion of the definition of innovation, the share of innovators at the current margin has grown in all enterprises size classes. The long-term downward trend shown for the period prior to the change in the definition also appears in all enterprise size classes (Figure 10).<sup>22</sup> The innovator rate dropped significantly from its peak in middle of the last decade (2004/2006) across all size classes. The smaller the surveyed companies are, the greater the loss of innovators is in the long term. The decline is -61% for businesses with fewer than five employees but 31% in large SMEs with 50 or more employees (measured here for the decline between 2002/2004 and 2016/2018).

#### Figure 10: Innovators by company size





Note: Figures extrapolated to the number of enterprises; with new OECD definition from 2017/2019: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

Throughout the period under review, it was evident that small enterprises are less likely to innovate than large ones. This is because small businesses have fewer resources and cover smaller markets.<sup>23</sup> 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.<sup>24</sup> Minimum project sizes and high fixed costs mean that innovations place a higher financial strain on small enterprises than on larger ones.<sup>25</sup>

#### ... and in all sectors

A sector analysis shows that the share of innovators has recently increased – at least moderately – in all business sectors. Before the definition was changed, a long-term decrease in innovation activity could be identified for all economic sectors surveyed (Figure 11). Since the start of this survey, R&D intensive manufacturing (e.g. mechanical engineering, electrical engineering or chemicals) exhibited a clearly undulating trend curve in the share of innovators, with slumps consistently followed by recovery phases. In the long term, however, the innovator rate has declined in R&Dintensive manufacturing as well (-24% in 2016/2018 on the 2004/2006 period).

#### Figure 11: Innovators by industry

In per cent



Note: Figures extrapolated to the number of enterprises; with new OECD definition from 2017/2019: Innovators inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

The innovator rate experienced a sharper drop in other (non-R&D-intensive) manufacturing, such as food and animal fodder production and metal products, for example. It fell by around 45% between 2002/2004 and 2016/2018. Still, innovation activity in manufacturing remained the steadiest of all sectors.

In the services sector, the innovator rate in knowledgebased services (e.g. IT and information service providers, law firms, tax accountants and management consulting firms) fell by nearly 60% between 2004/2006 and 2016/2018, while in the remaining (nonknowledge-based) services such as hospitality, transport and storage it even dropped by more than 60%. The sharpest drop in the innovator rate – 78% – was recorded in the construction industry.

#### Long-term trend: share of innovators is falling among small businesses and companies without R&D

The above changes in innovator rates in the individual groups of enterprises have significant impacts on the composition of innovators. The share of innovators in companies with fewer than five employees has dropped from the peak of 80% in the period 2004/2006 to 73% after the expansion of the definition. Since its peak (2009/2011), innovators without R&D as a percentage of all innovators fell by eight percentage points to 66% up to the 2016–2018 period. Expanding the definition of innovation by adding 'non-technical' innovations (marketing and organisational innovations) reduced this decline to 3 percentage points and a share of 70%.

With respect to the sectoral composition of innovators, the share of enterprises in the knowledge-based services sector among all innovators increased by 13 percentage points to 52%, while the share of innovators belonging to the sector of 'other services' dropped by 15 percentage points from its peak in 2010/2012. By contrast, the percentage of innovators in manufacturing companies rose moderately. The share of construction firms in innovators, in turn, dropped slightly. In particular, the trend at company size level in combination with the share of innovators without R&D means that it is primarily the diffusion of innovations across the breadth of the economy that has diminished over the past years.

### 4. Development of innovation expenditure before the coronavirus crisis

#### Innovation expenditure decreased in 2019

Despite the broader definition of innovation, innovation expenditure fell slightly in 2019 on the previous year. Aggregate innovation expenditure of SMEs is currently EUR 32.1 billion (Figure 12).<sup>26</sup> Innovation expenditure includes all spending on innovation including personnel costs and capital expenditure related to developing innovations and bringing them into the market.<sup>27</sup> The decline is likely due to the economic downturn that already began before the coronavirus crisis. It has probably made businesses more cautious. Innovation expenditure remained almost steady across the entire period of observation.

## Figure 12: Aggregate innovation expenditure in the SME sector



Note: Values extrapolated from the number of employees with new OECD definition from 2017/2019: Innovation expenditure inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

#### Large SMEs' innovation expenditure has decreased

Larger SMEs with five or more employees contributed most to the drop in innovation expenditure. With amounts ranging from EUR 1.9 billion for businesses with five to 10 employees to EUR 16.7 billion for companies with 50 or more employees, innovation expenditure in enterprises in these classes has fallen moderately (Figure 13). By contrast, businesses with fewer than five employees reported a slight increase in innovation expenditure, putting companies of this size back into a range last seen in 2016.

Across the entire period, innovation expenditure of large SMEs did not exhibit a temporal trend – despite a decreasing share of innovators – while small businesses reported a drop in innovation expenditure and a lower share of innovators. From a sectoral perspective, the drop in innovation expenditure is the result of developments in manufacturing and services (Figure 14). In the period under review, innovation expenditure in manufacturing was again near the average of the past six years, at just under EUR 10 billion. In knowledge-based services, after reaching a relatively high level in 2018, innovation expenditure during the period under review also dropped again to a level that is closer to the average. The sectors of other services also saw a decline in innovation expenditure on 2018. The expansion of the definition of innovation did not make up for the decline in these sectors. Only in the construction industry did innovation expenditure remain on a relatively steady level compared with 2018.

## Figure 13: Aggregate innovation expenditure by enterprise size



Note: values extrapolated from the number of employees; not counting enterprises of the remaining sectors, from 2019 with new OECD definition: Innovation expenditure inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations



### Figure 14: Aggregate innovation expenditure by sector

ing businesses with fewer than five employees; from 2019 with new OECD definition: Innovation expenditure inclusive of marketing and organisational innovations.

Source: KfW SME Panel, own calculations

### 5. Development of R&D activity before the coronavirus crisis

#### SMEs rarely conduct own R&D

As mentioned, many innovations by small and mediumsized enterprises are not based on their own R&D. R&D is defined as 'systematic creative work aimed at expanding existing knowledge [...] and using it with the objective of finding new potential applications'.<sup>28</sup> Instead, it is common for SMEs to develop innovations on the basis of experiential knowledge that emerges from the normal production process or in collaboration with customers and suppliers.<sup>29</sup>

In the period of 2017/2019, a mere 4% of SMEs conducted R&D continuously and a further 4% occasionally (Figure 15). Thus, the share of SMEs conducting R&D has developed without a trend over time across the past three survey waves. In absolute figures, this is a total of just under 300,000 SMEs with own R&D activities. In terms of innovation activity, that means a total of around 70% of SMEs introduce new or improved products and processes without conducting their own R&D.

### Figure 15: Enterprises with research and development activities of their own

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

After the economic and financial crisis, the share of SMEs conducting R&D initially dropped for several years and then rose again slightly. Since 2012/2014, however, that share continuously fell to 8% up to 2015/2017. The proportion of SMEs with their own R&D thus decreased by around half from the peak of 2004/2006. The expansion of the definition of innovation is not expected to have any major impact on the R&D activities measured, as the R&D definition is independent of the innovation definition being applied.

The decline in SMEs that conduct R&D is also cause for concern because they are, as it were, at the spearhead of innovation in the SME sector. With the high degree of novelty in their innovations,<sup>30</sup> these enterprises often bring new ideas to market, thereby driving technological progress and structural transformation.

### Long-term decline in the share of SMEs engaged in R&D in all size classes

In the individual enterprise size classes, too, the shares of SMEs conducting R&D have changed only minimally on the previous period. Large SMEs are much more likely to conduct their own R&D than other enterprises. In the period under review, 27% of SMEs with 50 or more employees conducted their own R&D (Figure 16).

### Figure 16: Enterprises with own (occasional or continuous) R&D by size





Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

In other words, large SMEs conduct almost twice as much R&D as enterprises with ten to fewer than 50 employees. That proportion is actually more than four times higher than in businesses with fewer than five employees. This is an indication that larger enterprises undertake innovation activities more systematically and make innovation processes more permanent.<sup>31</sup> A long-term downward trend in the shares of enterprises conducting R&D, however, can be observed in all size classes.

## R&D-intensive manufacturing SMEs conduct own R&D most often

R&D-intensive manufacturers are by far the most active in conducting own R&D, leading all other sectors by a wide margin (Figure 17). An undulating trend curve that could already be observed for innovation activity is also visible in R&D activity here. Currently, 41% of SMEs in this sector continuously or occasionally conduct R&D of their own, a slight increase on the previous period. This is a high rate compared with the other economic sectors and it is on this basis that this sector has a higher share of innovators than other economic sectors throughout the period under review.

### Figure 17: Enterprises with own (occasional or continuous) R&D by sector



Note: Figures extrapolated to the number of enterprises.

#### Source: KfW SME Panel, own calculations

Over much of the period under review, the shares of SMEs conducting their own R&D exhibit few differences between other manufacturing and knowledgebased services. Both sectors rank second and third, with similar values of 13 and 10%. An even lower percentage of other service providers conducts own R&D. R&D is least common in the construction industry.

### R&D expenditure was almost steady before the coronavirus

Aggregate R&D expenditure in the SME sector amounted to EUR 18.1 billion in the year 2019 (Figure 18). That was a minor decline on the previous year, which is likely attributable to the cyclical downturn. As R&D expenditure typically fluctuates less strongly than innovation expenditure across the business cycle, this decline is currently very moderate. Over the four-year period under review here, there are signs that R&D expenditure in the SME sector is experiencing a gentle upward trend.

### Figure 18: Aggregate R&D expenditure

in EUR bn



Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, own calculations

Despite their small number, large SMEs with 50 and more employees account for most of the aggregate R&D expenditure, as is the case with innovation expenditure. With EUR 9.5 billion out of a total of EUR 18.1 billion, R&D expenditure is similarly concentrated in large SMEs as innovation expenditure. Large SMEs reduced their R&D expenditure by EUR 0.5 billion on the previous year. This results in a moderate downward trend over the four-year period reviewed here. With the exception of small businesses with fewer than five employees, R&D expenditure – just like innovation expenditure – has also decreased minimally in the other enterprise size classes. Thus, the slightly positive trend of previous years among medium-sized SMEs has not continued (Figure 19).

As expected, manufacturers were at the top of all sectors for R&D expenditure, having spent EUR 6.5 billion (Figure 20). Enterprises in this sector slightly reduced their R&D expenditure on the previous year. Knowledge-intensive service providers made even lower cuts to their expenditure, and businesses providing other services reduced their expenditure very minimally. A clear temporal trend is observable in the business sectors over the four-year period.

### Figure 19: Aggregate R&D expenditure by company size



Note: values extrapolated from the number of employees, not counting enterprises of the remaining economic sectors.

Source: KfW SME Panel, own calculations

### Figure 20: Aggregate R&D expenditure by sector





Note: values extrapolated from the number of employees; not counting businesses with fewer than five employees.

Source: KfW SME Panel, own calculations

### 6. Conclusion

### Key findings on innovation activity in the SME sector

The share of innovators among SMEs has been on the decline for around 15 years. Since reaching its peak level during the 2004/2006 survey period, it dropped by nearly half (-49%) up to 2017/2019 – despite the current expansion of the definition. Small businesses in particular and – prior to the expansion of the definition of innovation to include 'non-technical' innovations enterprises without own R&D – have stopped innovating.

By contrast, aggregate expenditure on innovation in the SME sector has shown no clear trend. SMEs' innovation expenditure has remained nearly steady since 2013 and R&D expenditure has even shown a cautious upward trend in the past years. At the same time, overall business expenditure on innovation and R&D has grown for years.<sup>32</sup> That means innovation activity across the broad economy is on the decline, while innovation is concentrated in ever fewer and mainly large enterprises.

The downward trend in SMEs' innovation activity has also continued during the coronavirus pandemic. After a brief innovation surge at the beginning of the pandemic, small and medium-sized enterprises on balance reduced their innovation activities. Again, this applies in particular to small businesses and to enterprises that have suffered severe liquidity shortages and expect the crisis to continue for a long time. This is evidence that during the coronavirus crisis, financing innovations represents a particularly formidable challenge for businesses. SMEs that already innovated before the crisis are much less likely to reduce their innovation efforts during the crisis than businesses that did not innovate before the crisis.

## Financing difficulties and skills shortages are the main barriers to innovation

Already before the coronavirus crisis, the main barriers to innovation were the lack of qualified workers and financing obstacles. Both barriers have increased significantly in the past one and a half decades. The skills shortage even rose to the top of the list of innovation barriers a few years ago. According to the innovation survey conducted by the Leibniz Centre for European Economic Research (ZEW), 34% of all businesses are affected by skills shortages hampering innovation, very closely followed by finance-related barriers: high costs (34% of businesses), high risk (31%) and lack of internal funds (25%).<sup>33</sup> Scientific studies confirm the negative effects of these innovation barriers on the innovation activity of those affected and their business performance.<sup>34</sup>

The main cause of the skilled labour shortage is the demographic development, which is characterised by the accelerated retirement of baby boomers from the labour market coupled with declining numbers of secondary school graduates. The shortage is very palpable in the SME sector as well. The survey conducted under the KfW SME Panel in 2018 already showed two thirds of SMEs with job openings complaining about recruitment problems.<sup>35</sup>

More in-depth analyses also demonstrate that particularly in broad sections of SMEs which do not conduct R&D, lack of technical expertise and market information combined with the skills shortage previously described represent the main barriers to innovation.<sup>36</sup>

Difficulties in accessing finance have long ranked among the most formidable innovation barriers. They have also been mentioned much more often since the middle of the last decade – if less often than the shortage of skilled labour. The coronavirus crisis is accentuating financing aspects even more. It is making it more difficult to manage the trade-off between the desire for greater crisis resilience and the need for more investment in future competitiveness. As many enterprises will come out of the crisis in a tense liquidity situation and with higher debt, investment in future competitiveness in particular – such as innovation – is likely to rank further down the list of priorities even after the acute phase of the crisis has been overcome.

Innovation activity is being slowed by other causes as well. These include, for example, the long-term decline in the number of start-ups, the ageing of the workforce and latecomers possibly being discouraged.<sup>37</sup> Other causes mentioned are a reduced absorptive capacity of latecomers and better protection of their innovations by pioneer enterprises.<sup>38</sup>

#### Providing stronger incentives for innovation

The trade-off between investing in crisis resilience and in competitiveness means that innovation policy needs to provide businesses with more direct financial incentives to carry out innovation projects. Germany generally has an elaborate system of measures in place to promote innovation. They range from the promotion of innovative start-ups and technology-based start-ups – which KfW Research reports on elsewhere<sup>39</sup> – through pre-competition research (Industrial Collective Research "IGF") to support areas for the technology strategy and the sectoral programmes and thematically unspecified programmes (e.g. the Central Innovation Programme for SMEs "ZIM", KfW's innovation promotion). They broadly cover the spectrum of possible innovation projects. These measures are usually subject to different but clearly defined criteria for the

degree of novelty of the intended innovations as prerequisites for obtaining promotional funds. The granting of tax incentives to promote R&D expenditure was added last year as a new promotional approach that was long debated in Germany and is already being successfully applied in the majority of OECD countries.<sup>40</sup> Furthermore, measures are in place to improve networking and technology transfer and develop innovative competence.

Increased incentives can be provided by expanding and making existing offerings more attractive, filling existing support gaps and allocating sufficient funds to the measures. An international comparison shows that state support for innovation activity in the business sector is rather low compared with the USA, the UK, France and Italy, for example.<sup>41</sup>

## Innovation capacity needs to be incentivised on a broad scale

In order to counteract the decline in the rate of innovators and strengthen competitiveness across the breadth of the SME sector, however, it is also necessary to promote innovation activity in predominantly imitative SMEs (which typically do not conduct R&D). These innovators are important because they drive the diffusion of new technologies across the economy. Small businesses and companies without R&D in particular make up the bulk of enterprises. They account for a high proportion of Germany's economic output and employ a large share of workers. Research has shown that those enterprises can also be successful innovators and achieve significant growth.<sup>42</sup>

Particularly the hoped-for economic benefits of innovation and technological progress, such as economic growth and a renewed increase in productivity, will not be realised until technological progress is achieved across the economy as a whole.<sup>43</sup> Conversely, this also means that measures broadly aimed at the business community also increase the effectiveness of R&D support because higher absorptive capacity across the breadth of the enterprise sector improves the diffusion of new technologies.

However, measures aimed at supporting specific innovation projects financially often do not reach the affected businesses. One reason is that the vast portion of their innovation activity 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').<sup>44</sup> Another reason is that financing difficulties are not the main barrier to innovation for these businesses in particular.<sup>45</sup>

Important sources from which these enterprises 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. They also include the use of management practices that provide incentives to innovate and, not least, an established risk culture that promotes new ideas and accepts failure. In order to incentivise the relevant enterprises to innovate, these sources of innovative strength must be supported, thereby reinforcing their overall innovative capacity. Promotional measures aimed at building innovation capacity must therefore be expanded.<sup>46</sup> To achieve this, three key approaches can be identified:

- One starting point for economic and education policy is initial vocational training and continuing professional development. The skills basis for the innovation activities of these enterprises is typically made up of graduates of the dual system of vocational training in Germany and this is where interventions must start. An important basis for strengthening innovative capacity is therefore to continuously adapt training content to the changing technological environment and to follow the guiding principle of lifelong learning.
- Another approach is to improve access to external knowledge by cooperating in the region. Integration into regional innovation systems is of benefit, since particularly the enterprises referred to here often act locally, and regional innovation systems differ from one another. That enables businesses to bring their innovation activities in line with regional conditions.
- Finally, in-company processes of learning and understanding can be improved through corresponding management practices and adaptations to the work and business organisation, as described by the workplace innovation concept, for example.<sup>47</sup> For example, 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. Expanding innovation promotion to organisational innovations that promote these aspects could be a viable pathway to strengthening the innovative strength of small and medium-sized enterprises and businesses without own R&D in particular and thereby contributing in the medium term to growing these businesses' innovative activity. Tools that comprise promotional funds and, possibly, advisory services would be conceivable.

### Annex

#### The structure of innovative SMEs in 2017/2019

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 3.79 million SMEs exist in Germany. The SME sector thus accounts for 99.95% of all enterprises in Germany. Just under 840,000 of these enterprises are innovators.

The majority of innovative SMEs are small enterprises. Most innovative SMEs (around 410,000 enterprises, or 73%) have fewer than five employees. This high proportion of small innovators is due to the overall structure of small and medium-sized enterprises. Eighty-one per cent of SMEs have fewer than five employees. The manufacturing industry accounts for 11% of innovators while the service sector represents 86%.

Seventy per cent of innovative SMEs do not conduct any R&D of their own. A mere 15% research continuously and a further 15% undertook own R&D activities only occasionally in the past three years.

#### Figure 21: Innovative SMEs by company size





Note: Figures extrapolated to the number of enterprises. Source: KfW SME Panel, own calculations

#### Figure 22: Innovative SMEs by industry

In per cent



- R&D-intensive manufacturing
- Other manufacturing
- Construction
- Knowledge-based services
- Other services

Note: Figures extrapolated to the number of enterprises. Source: KfW SME Panel, own calculations

#### Figure 23: Innovative SMEs by own R&D activity

In per cent



No own R&D

Note: Figures extrapolated to 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. As it is representative of all SMEs of all sizes and across all branches in Germany, the KfW SME Panel offers projecttions for even the smallest companies with fewer than five employees. A total of 9,889 SMEs took part in the current wave.

Analyses of long-term structural developments in the SME sector are performed on the basis of the KfW SME Panel. It gives a representative picture of the current situation and the needs and plans of SMEs in Germany. The KfW SME Panel focuses on annually recurring information on companies' performance, investment activity and financing structure. This tool is the only way to determine 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 Financial Services Division of GfK SE 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 18th wave was conducted in the period from 10 February to 19 June 2020.

<sup>3</sup> Cf. Bravo-Biosca, A.; Marston, L.; Mettler, A.; Mulgan, G. and Westlake, S. (2013), Plan I – Innovation for Europe, Nesta and the Lisbon Council.

<sup>4</sup> Cf. Zimmermann, V. (2017), <u>Success factors of high-growth enterprises</u>, 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 only): 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 only),

<sup>&</sup>lt;sup>1</sup> Cf. Leibnitz-Centre for European Economic Research (2019): Innovationen in der deutschen Wirtschaft (*Innovation in the German private sector* – our title translation, in German only) and Stifterverband (2019): Forschung und Entwicklung in der Wirtschaft (*Research and development in the private sector* – our title translation, in German only).

<sup>&</sup>lt;sup>2</sup> Cf. Ulku, H. (2004): R&D, Innovation, and Economic Growth: An empirical Analysis, IMF Working Paper 04/195; OECD (2007) (publisher): 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.

DIW Wochenbericht 27, p. 755–761 and Gerstenberger, J. (2017): Produktivität des deutschen Mittelstands tritt auf der Stelle – Zeit zu handeln (Productivity of German SMEs has flatlined – time to act – in German only), Focus on Economics No. 172, KfW Research.

<sup>5</sup> 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 or. Zimmermann, V. and Thomä, J. (2019), <u>Interactive learning or R&D: How do small and medium-sized enterprises</u> generate innovations?, Focus on Economics No. 264, KfW Research

<sup>6</sup> 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.

<sup>7</sup> Cf. Zimmermann, V. and Thomä, J. (2019), <u>Interactive learning or R&D: How do small and medium-sized enterprises generate innovations?</u> 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.

<sup>8</sup> Cf. OECD and Eurostat (2018) (publishers), Oslo Manual 2018. Guidelines for collecting, reporting and using innovation data. OECD Publishing.

<sup>9</sup> Cf. Zimmermann, V. (2020): Innovation during the coronavirus crisis: necessity is the mother of invention, Focus on Economics No. 295, KfW Research.

<sup>10</sup> Cf. Rammer, C. (2021): Deutsche Wirtschaft bleibt trotz Corona-Pandemie auf Innovationskurs (*German economy remains on path of innovation despite the coronavirus pandemic* – our title translation, in German only). ZEW News March 2021, p. 6–7.

<sup>11</sup> Cf. Zimmermann, V. (2017): <u>SME Innovations: Seven reasons for the decline in the share of innovators</u>. Focus on Economics No. 185, KfW Research, Poschen, K. and Zimmermann, V (2014): <u>Falling sales expectations curb SME innovation activity in Germany</u>, Economics in Brief No. 58, KfW Economic Research, and in more detail Zimmermann, V. (2010): Innovation und Konjunktur (*Innovation and economic activity* – our title translation, in German only), Points of View No. 4, June 2010, KfW Economic Research.

<sup>12</sup> Cf. Schwartz, M., and Gerstenberger, J., (2021): <u>Zwar belastet die Corona-Krise den Mittelstand auch zu Jahresbeginn, allerdings bleibt die Lage trotz des</u> <u>Lockdowns stabil</u> (*The coronavirus crisis is weighing on SMEs at the start of the year too, but the situation is steady despite the lockdown* – in German only), Focus on Economics No. 315, KfW Research.

<sup>13</sup> Cf. Schwartz, M., and Gerstenberger, J., (2020): <u>KfW SME Panel 2020</u>, Coronavirus pandemic has dampened expectations for 2020 – SMEs entered the crisis from a strong position, KfW Research.

<sup>14</sup> Cf. Commission of Experts for Research and Innovation (2021): Report on Research, Innovation and Technological Performance in Germany. 2021 Report.

<sup>15</sup> Thus, in the supplementary survey of May the share of enterprises which the coronavirus crisis has put at risk of closure is 21% among small businesses with fewer than five employees, while that share is a mere 9% among SMEs with 50 and more employees.

<sup>16</sup> Cf. Dachs, B. and Peters, B. (2020): Covid-19-Krise und die erwarteten Auswirkungen auf F&E in Unternehmen (*COVID-19 crisis and expected impact on R&D in businesses* – our title translation, in German only), ZEW policy brief No. 2, April 2020.

<sup>17</sup> Cf. Zimmermann, V. (2021): <u>KfW SME Digitalisation Report 2020</u>. Digitalisation activity fell before Corona, ambivalent development during the crisis, KfW Research.

<sup>18</sup> Cf. Bertschek, I. (2020): Digitalisierung – der Corona-Impfstoff für die Wirtschaft (*Digitalisation as a corona vaccine for the German economy* – in German only), Wirtschaftsdienst 2020/9, p. 653–656.

<sup>19</sup> The KfW SME Panel captures whether an enterprise has introduced innovations for a three-year period using the method commonly applied across Europe. Initially the KfW SME Panel surveyed innovative activity only every two years.

<sup>20</sup> Cf. Zimmermann, V. (2018): Determinants of digitalisation and innovation behaviour in the SME sector, Focus on Economics No. 236, KfW Research.

<sup>21</sup> Cf. OECD and Eurostat (2018) (publishers), Oslo Manual 2018. Guidelines for collecting, reporting and using innovation data. OECD Publishing.

<sup>22</sup> The number of employees is calculated including the active owners but excluding trainees and apprentices. Two part-time employees are counted as one fulltime employee.

<sup>23</sup> 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.

<sup>24</sup> Cf. Galbraith, J. K. (1952): American Capitalism. The Concept of Countervailing Power. Boston, Houghton 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.

<sup>25</sup> Cf. Zimmermann, V. (2020): <u>KfW SME Innovation Report 2019</u>: Innovator rate drops to 19%, KfW Research.

<sup>26</sup> Owing to changes in the structure of the questionnaires, the surveys of innovation expenditure prior to 2013 are not directly comparable with current figures.

<sup>27</sup> 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.

<sup>28</sup> Cf. OECD (2015) (publisher.): Frascati Manual 2015. Guidelines for collecting and reporting data on research and experimental development.

<sup>29</sup> Cf. Zimmermann, V. and Thomä, J. (2019), <u>Interactive learning or R&D: How do small and medium-sized enterprises generate innovations?</u>, 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.

<sup>30</sup> Cf. Zimmermann, V. (2019): KfW SME Innovation Report 2018. Innovator rate has fallen again, KfW Research.

<sup>31</sup> Cf. Zimmermann, V. (2017): KfW SME Innovation Report 2016: Innovation is concentrated in increasingly fewer enterprises,

KfW Research.

<sup>32</sup> Cf. Leibnitz-Centre for European Economic Research (2019): Innovationen in der deutschen Wirtschaft (*Innovation in the German private sector* – our title translation, in German only) and Stifterverband (2019): Forschung und Entwicklung in der Wirtschaft (*Research and development in the private sector* – our title translation, in German only).

<sup>33</sup> Cf. ZWE – Leibniz Centre for European Economic Research GmbH (ed., 2020): Indikatorenbericht zur Innovationserhebung 2019 (*Indicator report on innovation survey 2019* - in German only).

<sup>34</sup> Cf. Hornbach, J. und C. Rammer (2020): Labor Shortage and Innovation, ZEW Discussion Paper No. 20-009, or Coad, A.; Pellegrino, G. and Savona, M. (2016): Barriers to innovation and firm productivity, Economics of Innovation and New Technology 25(3): 321–334.

<sup>35</sup> Cf. Leifels, L. (2018): Many job openings, few job seekers: SMEs expect a shortage of skilled workers, Focus on Economics No. 232, KfW Research.

<sup>36</sup> Cf. Zimmermann, V. and Thomä J. (2016), <u>SMEs face a wide range of barriers to innovation – support policy needs to be broad-based</u>, Focus on Economics No. 130, KfW Research.

<sup>37</sup> The reasons for this and possible implications for economic policy have been intensively discussed by KfW Research in the past years. Cf. Zimmermann, V (2018), <u>KfW SME Innovation Report 2017: Trend towards fewer innovators continues</u>, KfW Research, Zimmermann, V. (2017), <u>SME innovations: Seven reasons for the decline in the share of innovators</u>, Focus on Economics No. 185, KfW Research, or Zimmermann, V. and Thomä, J.: (2016), <u>SMEs face a wide range of barriers to innovation activity – support policy needs to be broad-based</u>, Focus on Economics No. 130, KfW Research.

<sup>38</sup> Cf. Wambach, A. and Weche, J.P. (2020): Sektorübergreifende Konzentrations- und Margenzunahme: Bestandsaufnahme, Ursachen und Folgen (*Cross-sector increase in concentration and margins: current status, causes and effects* – our title translation, in German only), Perspektiven der Wirtschaftspolitik 21(2), p. 120–136.

<sup>39</sup> Cf. Metzger, G. (2020): <u>KfW Start-up Report 2020</u>. Number of start-ups in Germany was steady at 70,000 in the year 2019; impact of the coronavirus crisis is uncertain, KfW Research, and Fernández Acevedo, M. et al (2016) <u>France, Germany, Italy, Spain and the United Kingdom: Building Momentum in Venture Capital across Europe</u>, KfW Research.

<sup>40</sup> Cf. 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.

<sup>41</sup> Cf. Rammer, C. and Schubert, T. (2016): Concentration on the Few? R&D and Innovation in German Firms 2001 to 2013, ZEW Discussion Paper No. 16-005.

<sup>42</sup> Cf. 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, 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.

<sup>43</sup> Cf. Schiersch, A. (2019): Frontiers und Laggards. Die Produktivitätsentwicklung deutscher Unternehmen (Frontiers and laggards. *Productivity development of German enterprises* – our title translation, in German only), Bertelsmann Stiftung, and Andrews, D., Criscuolo, C and Gal, P. N. (2016): The best versus the rest: The global productivity slowdown, divergence across firms and the role of public policy, OECD Productivity Working Papers No. 05.

44 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.

<sup>45</sup> Cf. Zimmermann, V. and Thomä J. (2016), <u>SMEs face a wide range of barriers to innovation – support policy needs to be broad-based</u>, Focus on Economics No. 130, KfW Research.

<sup>46</sup> Cf. Rammer, C. and Schmitz, F. (2017): Fortentwicklung der EFI-Indikatorik: Förderlandschaft. Studien zum deutschen Innovationssystem (*Refining the set of indicators of the Commission of Experts for Research and Innovation: Promotional landscape. Studies on Germany's innovation system* – our title translation, in German only) No. 9-2017.

<sup>47</sup> Cf. Totterdill, P. (2015): Closing the Gap: The Fifth Element and Workplace Innovation, European Journal of Workplace Innovation, 1(1): 55–74.