

## »» Determinants of digitalisation and innovation behaviour in the SME sector

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SMEs' digitalisation and innovation activities are influenced by similar factors. Both are creative activities in which something new is developed or implemented within the enterprise or brought to market. On closer inspection, however, it is evident that the factors which determine enterprises' digitalisation and innovation activity have different weight.

Digitalisation projects are much less concentrated in specific groups of enterprises than innovation activities. This applies with respect to enterprise age, size and sales region, for example. Almost regardless of their size, SMEs carry out digitalisation projects around 10 percentage points more often than innovation projects. Enterprises with a regionally restricted sales area digitalise their operations a good one third more often than they develop innovations. Moreover, the implementation of digitalisation projects is less dependent on the business cycle than innovation activity. These findings indicate that digitalisation has arrived in the SME sector at large.

Nevertheless, digitalisation projects are carried out primarily in enterprises that are being directed by young managers. By contrast, there is no evidence that work on innovations declines that much with increasing age of managers. Finally, graduates in the enterprise (whether employees or entrepreneurs) favour digitalisation and innovation activity to a similar degree.

### Innovation and digitalisation drive competitiveness and growth

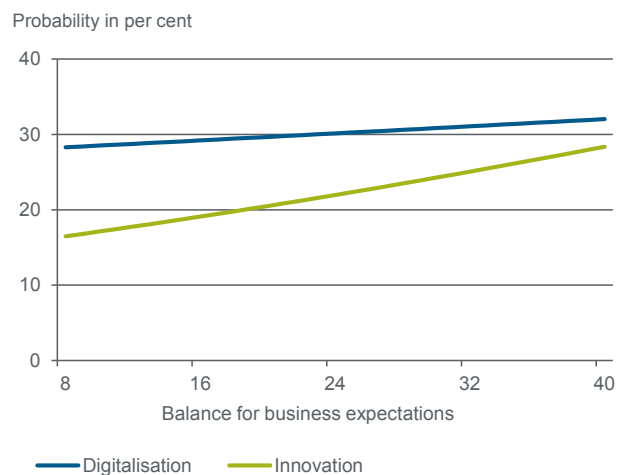
Innovations and digitalisation are regarded as key drivers of competitiveness and economic growth. Numerous studies have identified positive effects, both at aggregate economic level and on business performance.

Digitalisation and innovation projects have similar characteristics. Both concern the development or introduction of something new to the enterprise or the market. Innovations are typically understood as the introduction of new or significantly improved products and processes. Digitalisation is usually defined more broadly. It also comprises the further development of the business model, business organisation or marketing and sales methods. However, digitalisation is limited to IT and information and communication (IC) technologies and microsystem technology.

It is therefore plausible that both activities are influenced by similar business characteristics. This paper explores these

considerations. With the aid of a multivariate analysis, it examines the factors that cause a small or medium-sized enterprise to bring forth innovations or carry out digitalisation projects (Box: database and methodology). Enterprises' innovation behaviour is particularly well studied. The comparison between digitalisation and innovation behaviour helps to identify the particular characteristics of digitalisation.

### Figure 1: Implementation of digitalisation or innovation projects as a function of the business cycle



Note: The business cycle is mapped on the basis of business expectations. Medium-term business expectations are calculated from the balance of positive minus negative reports on three-year expectations for turnover development at sector level.

Source: KfW SME Panel, own calculations

### Business cycle only has a moderate influence on the implementation of digitalisation projects

Both the development of innovations and the implementation of digitalisation projects depend on enterprises' turnover expectations (at sector level). The link is particularly close for the implementation of innovations (Figure 1).

The likelihood that a business brings forth innovations increases by a good two fifths when the business cycle assessment (balance of positive minus negative responses) is 33 balance points instead of 13 balance points.<sup>1</sup> The same variation increases the likelihood of implementing digitalisation projects by only one twelfth.<sup>2</sup>

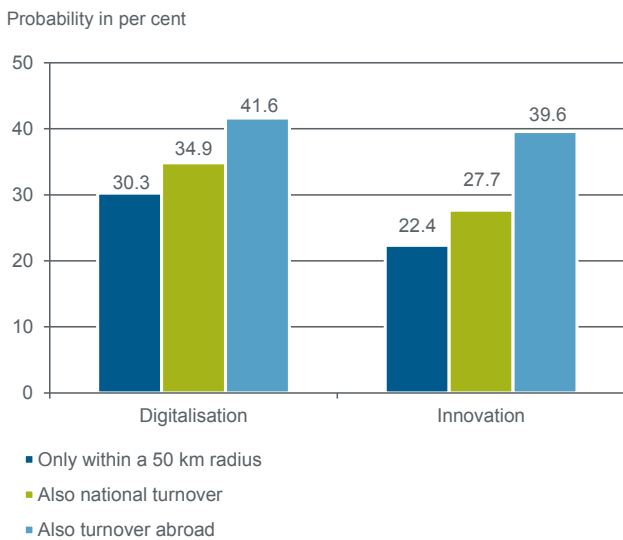
One likely reason for the lower importance of the business cycle for the implementation of digitalisation projects is that currently digitalisation projects are rarely aimed at changing the product range.<sup>3</sup> Studies have shown that bringing forth

product innovations in particular is influenced by the business cycle. This applies much less to process innovations, on the other hand.<sup>4</sup> The reason that innovations are relatively dependent on the business cycle lies in the high share of product innovations in total innovation activity.

**Investment activity more strongly concentrated in enterprises with international operations**

Internationally operating enterprises are deemed to be more innovative than enterprises that do business only in national or regional markets. This is because they face stiffer competition and are therefore under particular pressure to keep their products up-to-date and their processes efficient. Another reason given is that their presence in international markets is a source of new knowledge and ideas that nurtures innovation activity.<sup>5</sup>

**Figure 2: Implementation of digitalisation and innovation projects as a function of the sales region**



Source: KfW SME Panel, own calculations

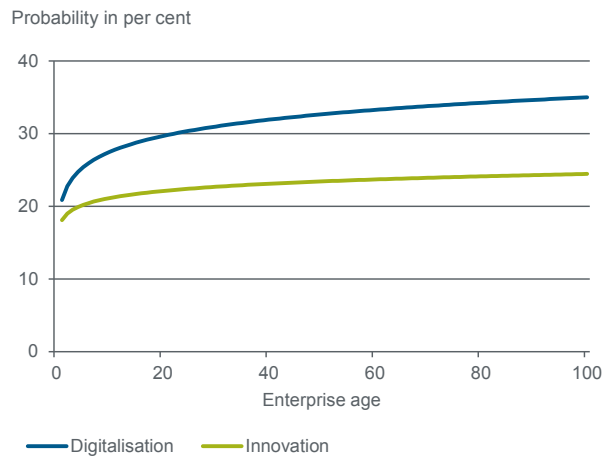
The analysis does in fact show that internationally operating enterprises innovate around one and three quarter times more often – with a probability of just under 40 % – than enterprises that generate turnover only within a 50 km radius of their registered office (Figure 2). This span is significantly shorter for digitalisation. Internationally operating enterprises also conduct digitalisation projects more often. But they are only a good one and a third times more likely to implement digitalisation projects than regionally operating businesses. This is mainly because a relatively high share of enterprises with a regional focus also carries out digitalisation projects. The share of enterprises with digitalisation projects is a good one and a third times higher in this group than the share of enterprises with innovation projects. This finding can be interpreted as an indication that digitalisation is being generally accepted by more and more enterprises.

**More older enterprises are going digital**

Young enterprises are often regarded as more innovative than older ones. But some factors also suggest that older enterprises are making greater efforts to innovate. For example, older enterprises can draw on more extensive

resources because it is easier for them to finance high-risk projects.<sup>6</sup> Besides, the multivariate analysis conducted here has also calculated a high number of factors that influence innovation activity that may be related to the age of the enterprise. These include the age of the entrepreneur or the employees' level of formal education, for example (see below). The findings for the age of the enterprise in this analysis may therefore turn out differently from those that would be obtainable from a simple evaluation of innovation activity based exclusively on enterprise age.

**Figure 3: Implementation of digitalisation and innovation projects as a function of enterprise age**



Source: KfW SME Panel, own calculations

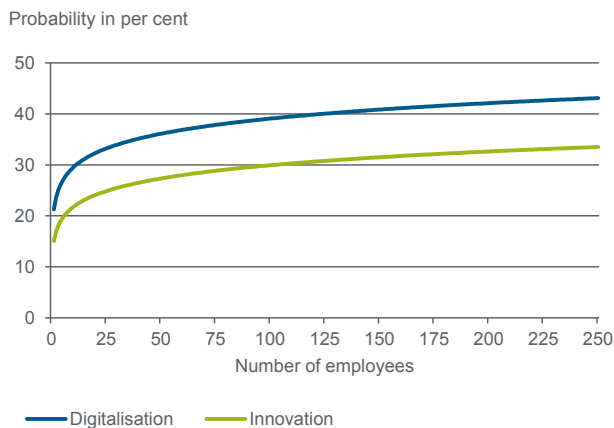
If we separate out the effects of further enterprise characteristics on innovation and digitalisation activity, the present analysis concludes that – all other factors remaining equal – innovation activity increases slightly with rising enterprise age (Figure 3). The likelihood of developing innovations increases by 4.0 % when an enterprise is 47 instead of 24 years old.<sup>7</sup>

The likelihood of completing digitalisation projects nearly doubles (7.3 %) with the same variation.<sup>8</sup> At first glance, the more frequent digitalisation activities of older enterprises may come as a surprise. But this finding corroborates those of other studies.<sup>9</sup> The likely reason is that older enterprises in particular more often need to play digital catch-up. Newly founded enterprises, by contrast, probably start off with a higher degree of digitalisation already.

**Large enterprises innovate and digitalise more often**

Both digitalisation and innovation activity typically grow with the size of the enterprise.<sup>10</sup> The present analysis also corroborates this finding (Figure 4). Both curves exhibit a nearly identical gradient. The curve for digitalisation, however, begins on a higher level than the curve for innovations.<sup>11</sup> For almost the entire spectrum of enterprise sizes, the curve describing the implementation of digitalisation projects is just under 10 percentage points higher than for innovations. This can also be seen as an indication that digitalisation has arrived in the SME sector at large.

**Figure 4: Implementation of digitalisation and innovation projects as a function of enterprise size**



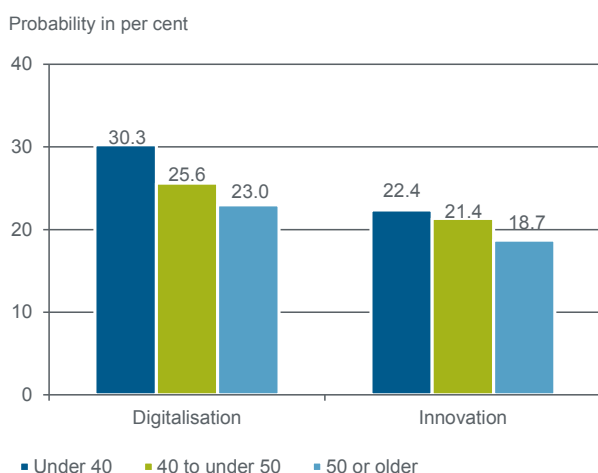
Source: KfW SME Panel, own calculations

**Digitalisation is a domain of young entrepreneurs**

Innovation activity declines as the business owner ages. This applies in particular to the development of process innovations, which shows similar declines as in investment. But this phenomenon can hardly be observed for product innovations. The decline in process innovations is likely due to the fact that they have relatively long payback periods that extend beyond the time of (age-related) business succession or transfer. The synchronicity with investment activity results from the fact that process innovations are also composed of investment expenditure to a higher proportion.<sup>12</sup>

The present analysis has also revealed that the probability of bringing forth innovations is roughly one-seventh lower when the business owner is 50 years or older compared with one who is younger than 40 (Figure 5). But the drop in innovation activity in the medium age group of entrepreneurs (from 40 to under 50 years) is negligible.<sup>13</sup>

**Figure 5: Implementation of digitalisation and innovation projects as a function of the age of the owner-manager**



Source: KfW SME Panel, own calculations

The age of the owner-manager was found to have a significantly stronger influence on digitalisation projects, however. The probability of carrying out digitalisation projects is already almost one seventh lower in the group of 40 to under 50-year-olds than among younger entrepreneurs. This gap even widens to around one fourth for entrepreneurs aged 50 and over.

This sharp drop is probably caused by a range of factors. For one thing, digitalisation expenditure involves a higher investment share than innovations. In digitalisation projects it is around 50% but in innovation projects this share averages a mere 30%.<sup>14</sup> Innovation projects in particular are deemed very labour cost-intensive. The problem of a longer payback period is therefore likely to be more pronounced for digitalisation projects than for innovations.

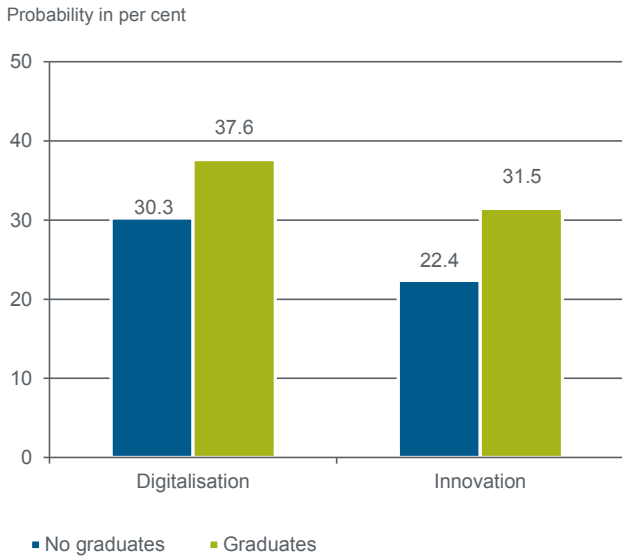
For another thing, studies have revealed that young people in particular use digital technologies earlier in their day-to-day work than older people.<sup>15</sup> But the broad diffusion of digitalisation projects in enterprises managed by young owners is also likely to be partly due to the fact that younger entrepreneurs are more receptive to digital technologies. This finding thus corroborates the role which ‘digital natives’ play for successful digitalisation, which is often emphasised in public debate.

**High educational qualifications benefit digitalisation and innovation**

Finally, Figures 6 and 7 show that tertiary graduates in particular drive digitalisation and innovation activity. Specifically, the level of formal education of employees and entrepreneurs has been found to have a greater effect on innovation activity than on digitalisation. For enterprises that employ graduates, the likelihood of bringing forth innovations is two fifths higher. For digitalisation the likelihood is nearly one quarter higher. The entrepreneur’s formal qualifications raise the probability by nearly one fifth for innovation compared with one tenth for digitalisation. However, statistical tests to verify these values showed that the relevant differences between the implementation of innovation and digitalisation projects are not statistically significant.<sup>16</sup>

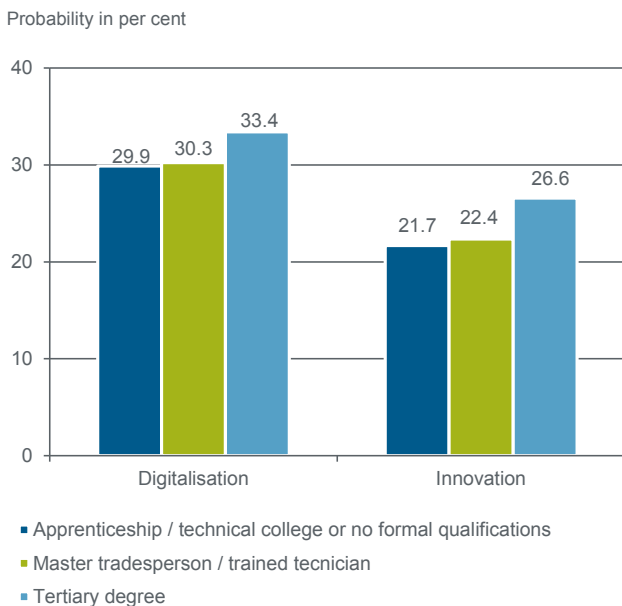
With respect to the owner-manager’s level of formal qualifications, it has also been shown that only a tertiary degree has an impact on innovation or digitalisation output. By contrast, whether an entrepreneur is a master tradesperson, trained technician, has completed an apprenticeship, holds a certificate from a technical college or no formal qualifications at all is not relevant for the probability of making innovations or implementing digitalisation projects.

**Figure 6: Implementation of digitalisation and innovation projects as a function of the presence of graduates in the company workforce**



Source: KfW SME Panel, own calculations

**Figure 7: Implementation of digitalisation and innovation projects as a function of the owner-manager’s formal qualifications**



Source: KfW SME Panel, own calculations

**Conclusion**

Businesses’ innovation and digitalisation activities are influenced by similar factors. This was to be expected because these activities are closely related. Both are creative activities in which something new is produced from the viewpoint of the business, implemented within the business or brought to market. On closer inspection, however, some factors differ in the way they affect the implementation of innovation and digitalisation projects.

Digitalisation is less dependent on the geographic expansion of the sales region than innovations. Moreover, digitalisation projects are conducted more frequently than innovations, even by small businesses. Both findings underscore that digitalisation is now less confined to specific groups of SMEs but is being increasingly embraced by the SME sector at large. This is also evidenced, for example, by the fact that older enterprises are more likely to initiate digitalisation projects than young enterprises – all other factors remaining equal.

The lower dependence of digitalisation projects on enterprises’ business cycle expectations must also be seen as positive. After all, cyclicity can lead to an undesired slowdown in the necessary structural transformation when the business cycle weakens. What remains to be seen is whether or not the hitherto weak reactivity to the business cycle strengthens if enterprises’ digitalisation projects target products and services or new business models more frequently than they have. The risk therefore exists that the weak dependence on the business cycle that has been observed may be not more than the result of a lack of digitalisation efforts involving marketing activities.

What is a cause for concern, however, is that digitalisation projects are to a great extent the domain of young entrepreneurs. The demographic development and the declining start-up rate have caused the age composition of entrepreneurs to shift increasingly upward to older ages. This threatens to slow down digitalisation in the SME sector more and more.

Finally, it is evident that tertiary qualifications in particular encourage the production and implementation of new things in an enterprise – and this applies to digitalisation and innovations in equal measure. This indicates that a university education in particular builds the skills for such creative activities. From the viewpoint of innovation and digitalisation, strong efforts should therefore be undertaken to avoid skills shortages, particularly among tertiary graduates. It is true that the numbers of tertiary students have already increased in past years but as the numbers of school leavers are declining, even higher proportions of school leavers from each year should be encouraged to take up degree courses in the future. The strong correlation between students’ pursuit of a degree course and their parents’ level of education points to the existence of unused potentials.<sup>17</sup> ■

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### **Box: Dataset and methodology**

We analysed the factors that determine whether an enterprise completes digitalisation projects or develops innovations over a three-year period. The following characteristics were taken into account in the regression: Number of employees (in full-time equivalents), age of company (both logarithmised), employment of university graduates, sales region, three-year turnover expectations at the level of the industry in which the company operates, collective industry to which it belongs, group to which it belongs, legal status, KfW support status, region of company's registered office and time of survey. The gender, highest level of education and age of the entrepreneur were also taken into account. All data of the time-varying variables (with the exception of three-year turnover expectations) refer to the time prior to the measurement of digitalisation and innovation activity.

The analysis was conducted with the aid of a bivariate probit model (table at end of page). It was based on nearly 6,600 observations of the past to survey waves of the KfW SME Panel which were taken from nearly 4,700 different, mostly small businesses. Thus, the median in the sample is merely 12 employees. The standard errors were computed taking into account the fact that one enterprise may make several observations.<sup>18</sup> The observation period for digitalisation and innovation activities covers the years 2014 to 2017.

Regression results are illustrated using model calculations. The influence of a characteristic on the likelihood of completing digitalisation projects or producing innovations can be described by varying a characteristic in the model calculations while leaving all other enterprise characteristics unchanged.

	Digitalisation		Innovation	
	Coefficient	robust t-value	Coefficient	robust t-value
Log (employees)	0.11293	6.06	0.11002	5.72
Group affiliation: Subsidiaries	0.09119	1.64	0.06713	1.16
Log (age of enterprise)	0.09234	4.04	0.04770	2.08
Dummy: employment of graduates	0.20204	4.60	0.27784	6.28
<b>Sales market</b>				
50 km region	Reference category		Reference category	
with sales across Germany	0.12773	2.76	0.16718	3.44
with sales outside Germany as well	0.30532	5.84	0.49534	9.35
3-year turnover expectation in the sector	0.33554	1.72	1.25830	6.35
<b>Sector to which the enterprise belongs</b>				
R&D-intensive manufacturing industry	Reference category		Reference category	
Other manufacturing industry	-0.09035	-0.95	0.12349	1.27
Construction	-0.01506	-0.13	-0.26491	-2.20
Knowledge-based services	0.41120	4.12	-0.02646	-0.26
Other services	0.08210	0.86	-0.13544	-1.40
Dummy: legal form with limited liability	-0.00337	-0.07	0.07014	1.53
<b>Age class of owner-manager</b>				
under 40 years	Reference category		Reference category	
40 to under 50 years	-0.13846	-1.97	-0.03427	-0.47
50 years and older	-0.22270	-3.24	-0.12852	-1.82
<b>Owner-manager's formal qualifications</b>				
Apprenticeship/technical certificate or no qualifications	-0.01048	-0.19	-0.02254	-0.40
Master tradesperson/technician	Reference category		Reference category	
Tertiary degree	0.08857	1.82	0.13474	2.67
Dummy: owner-manager's gender: Female	0.01054	0.18	-0.04114	-0.65
Dummy: not promoted by KfW	-0.05901	-1.47	-0.07658	-1.81
Dummy: Region of registered office: Eastern Germany	-0.12407	-3.05	-0.14082	-3.30
<b>Year of survey (explanatory variable)</b>				
2014	Reference category		Reference category	
2015	0.24958	8.58	-0.08422	-2.87
Constant	-1.42490	-8.93	-1.41624	-8.78
/athrho	0.47525	18.80		
rho	0.44243			
Number of employees		6,636		
Wald test (all explanatory variables =0)		chi2(40)=1029.84		
Wald test (rho=0)		chi2(1)=353.598		
Log Likelihood		-7259.4486		

<sup>1</sup> The values correspond with the first and third quartile in the sample.

<sup>2</sup> A Wald test rejects the null hypothesis that the underlying regression coefficients regarding innovation and digitalisation are identical with a P-value of 16.15 [chi2(1)=0.000]. The underlying regression coefficient regarding the influence of the business cycle digitalisation, however, has only weak significance (on the 10% level).

<sup>3</sup> Zimmerman, V. (2018), **Digitalisation in German SMEs: state of implementation and investment**, Focus on Economics No. 202, KfW Research.

<sup>4</sup> Cf. Zimmermann, V. (2017): **Innovations in the SME sector: seven reasons for the decline in the share of innovators**, Focus on Economics No. 185, KfW Research, or Poschen, K. and Zimmermann, V. (2014): **Falling sales expectations curb SME innovation activity in Germany**, Economics in brief No. 58, KfW Economic Research.

<sup>5</sup> Cf. Schlegelmilch (1988) or Greenaway and Kneller (2007), and Andersson and Lööf (2009).

<sup>6</sup> Cf. Müller, E. und V. Zimmermann (2009), The importance of equity finance for R&D activity, *Small Business Economics* 33/3: 303–318.

<sup>7</sup> The values correspond with the median and third quartile in the sample.

<sup>8</sup> A Wald test rejects the null hypothesis that the underlying regression coefficients are identical with a P-value of 2.87 [chi2(1)=0.0900].

<sup>9</sup> More frequent digitalisation activities by older enterprises can be identified in the business survey conducted by KfW in collaboration with business associations, for example. Cf. Zimmermann, V. (2018): **Business Survey 2018: Digitalisation is gaining momentum**. KfW Research. Cf. also the study by Saam, M. et al. (2016): Digitalisierung im Mittelstand: Status Quo, aktuelle Entwicklungen und Herausforderungen (*'Digitalisation in SMEs: status quo, current trends and challenges'* – our title translation, in German only). Research project on behalf of KfW Group concluded that young enterprises do not initiate digitalisation projects more often than older ones.

<sup>10</sup> Cf. Zimmerman, V. (2018), **Digitalisation in German SMEs: state of implementation and investment**, Focus on Economics No. 202 and Zimmermann, V (2018): **KfW SME Innovation Report 2017. Trend towards fewer innovators continues**, KfW Research. Enterprise size is measured by the number of employees. These include full-time and part-time employees, as well as owners actively involved in enterprise management but no trainees or apprentices. Two part-time employees are counted as one full-time employee.

<sup>11</sup> This impression is confirmed by an additional Wald test. It does not reject the null hypothesis that the two regression coefficients for the influence of enterprise size are equal with a P-value of 0.02 [chi2(1)=0.8928].

<sup>12</sup> Cf. Zimmermann, V. (2018): Sinkt mit zunehmendem Alter des Unternehmers der Innovationsoutput mittelständischer Unternehmen? (*Does innovation output of SMEs decline as entrepreneurs age?*) *ZfKE – Zeitschrift für KMU und Entrepreneurship* 66(3), p. 153–184 or Zimmermann, V. (2013): **Have the old still got what it takes? Differences in the innovative output of young and old entrepreneurs**, Focus on Economics No. 33, KfW Economic Research.

<sup>13</sup> Besides, the underlying regression coefficient for the group of 40 to under 50-year-olds is not significantly distinct from null.

<sup>14</sup> Cf. Saam, M. Viète, S. and Schiel, et al. (2016): Digitalisierung im Mittelstand: Status Quo, aktuelle Entwicklungen und Herausforderungen (*'Digitalisation in SMEs: status quo, current trends and challenges'* – our title translation, in German only), research project commissioned by KfW Group. Rammer et al (2017): Innovation behaviour in German enterprises. Indikatorenbericht zur Innovationserhebung (*Indicator report on innovation survey 2016*) (in German only).

<sup>15</sup> Cf. Meyer, J. (2011): Workforce age and technology adoption in small and medium-sized service firms, *Small Business Economics* 37(3), p. 305–324 or Weinberg, P. (2004): Experience and technology adoption, IZA Discussion Paper 1051.

<sup>16</sup> The relevant null hypotheses that the underlying regression coefficients are identical were not rejected, with a P-value of 2.19 [chi2(1)=0.1393] (employees with tertiary degrees) and with a P-value of 0.63 [chi2(1)=0.4292] (entrepreneur with a tertiary degree).

<sup>17</sup> Cf. Leifels, A. (2016): Bildungshürden und Studienfinanzierung in Deutschland (Educational obstacles and student finance in Germany – our title translation, in German only). Focus on Economics No. 144, KfW Research.

<sup>18</sup> Cf. Huber, P. J. (1967): The behaviour of maximum likelihood estimates under non-standard conditions, *Proceedings of the Fifth Berkley Symposium on Mathematical Statistics and Probability* 1: 221–233, and White, H. (1982): Maximum Likelihood Estimation of Misspecified Models, *Econometrica* 50: 1–25.